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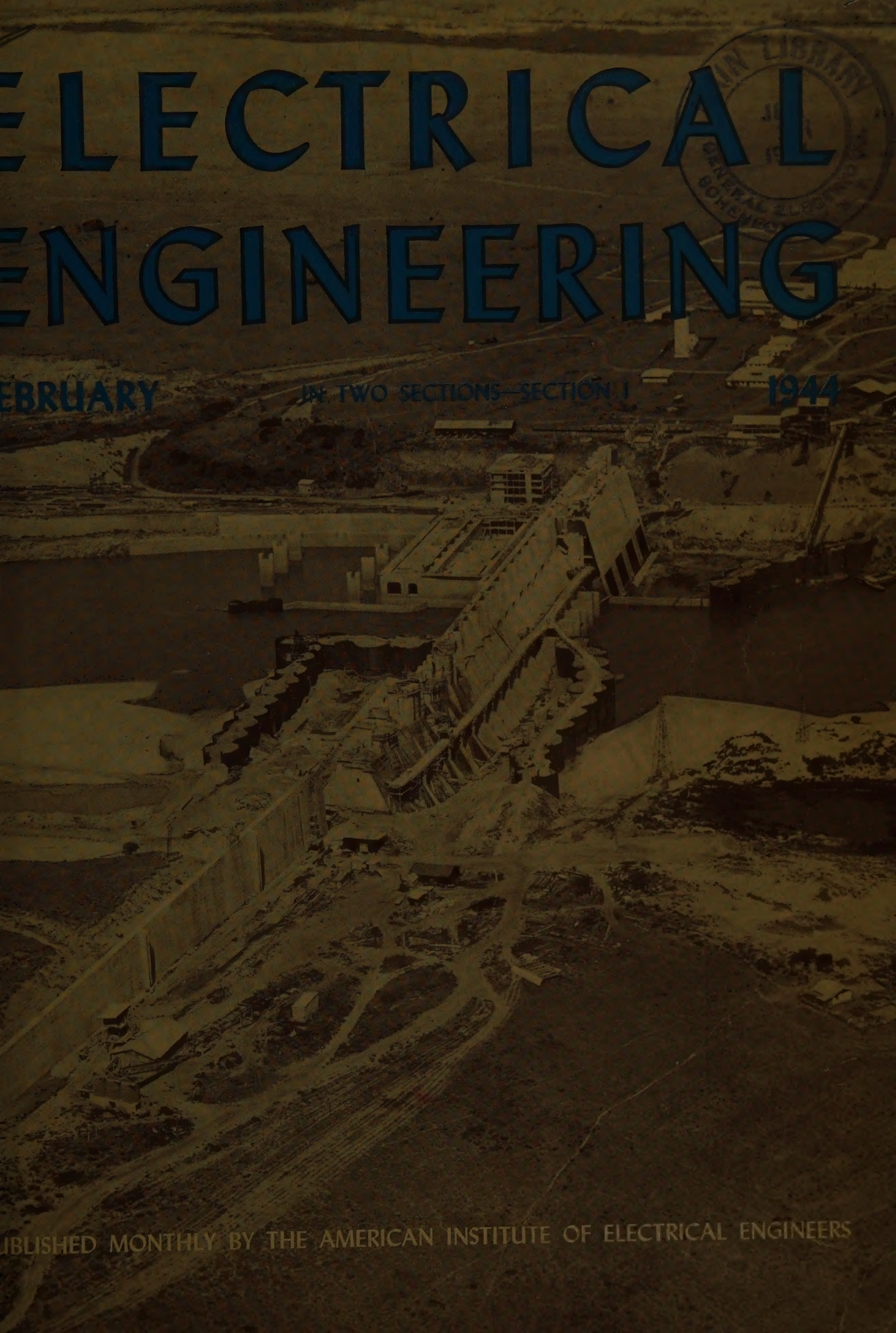

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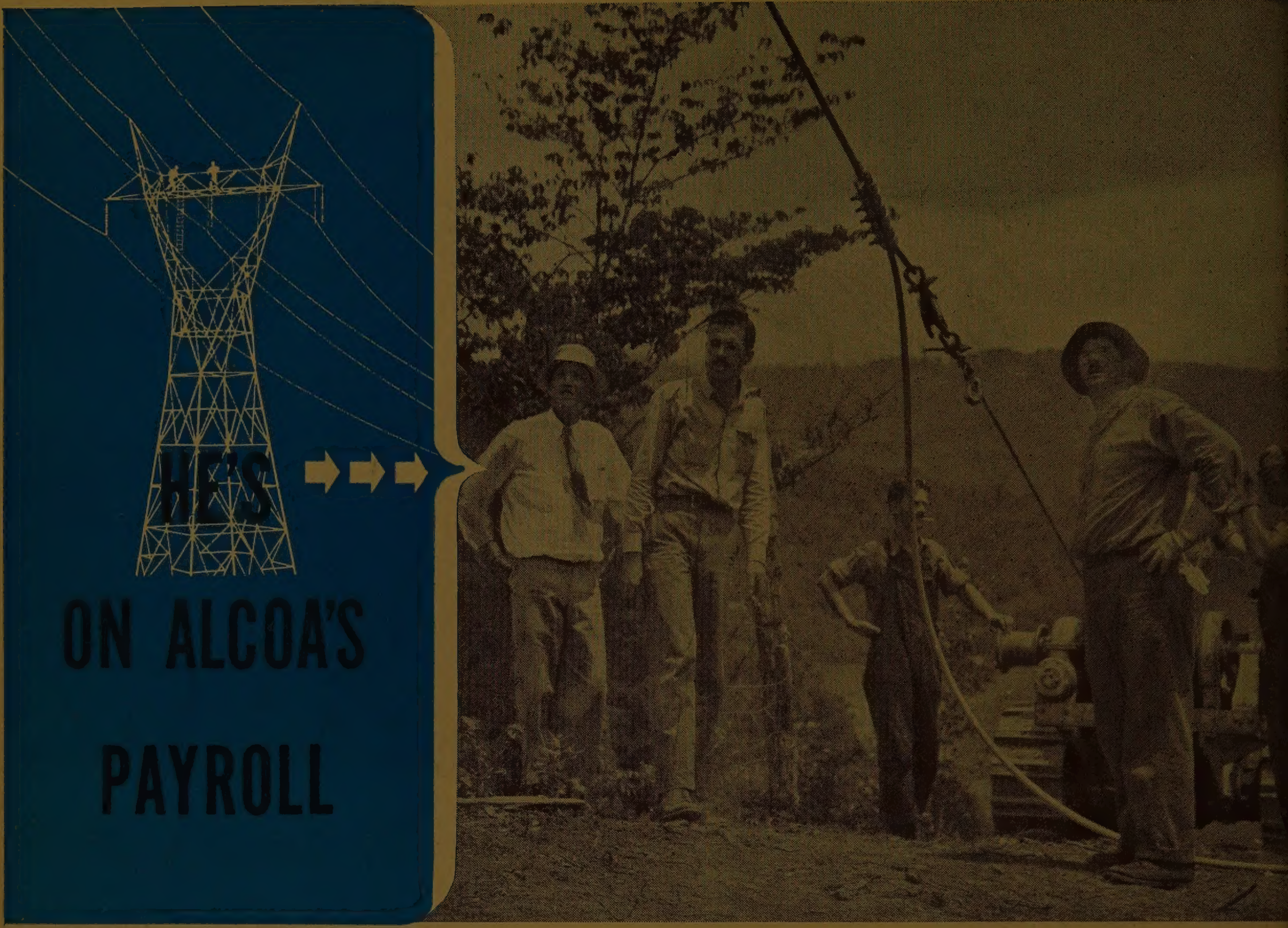

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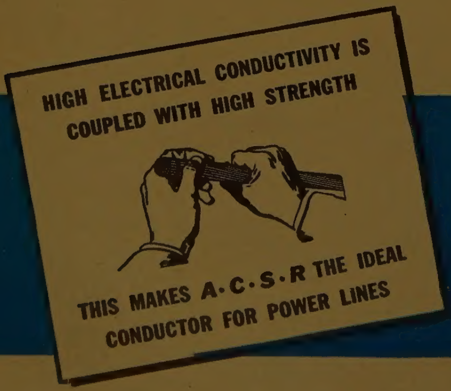
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The Cover: The first of four 30,400-kw waterwheel generators will soon be installed at the Rio Negro dam and power house in Uruguay. Construction on this 3,850-foot dam was begun in 1937 by a European contractor; the work is now being continued under the supervision of a United States company.

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A NEW RESOURCE HAS BEEN DEVELOPED

THE WEALTH of America has been wrought from her natural resources of fertile lands, wide forests and rich mineral deposits by the brains and muscles of her people.

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ELECTRICAL ENGINEERING
VOLUME 63, NUMBER 2 FEBRUARY 1944

Electrification for Latin America

CHARLES A. HOWARD

ALTHOUGH the continent of South America is exceptionally well endowed by nature with valuable mineral resources, its deposits of coal that are of commercial value are extremely limited. Most of the deposits which exist are insufficient in quantity, poor in quality, or badly located with reference to consuming centers. The need for importing large quantities of fuel is a heavy burden on the economies and finances of most South American countries.

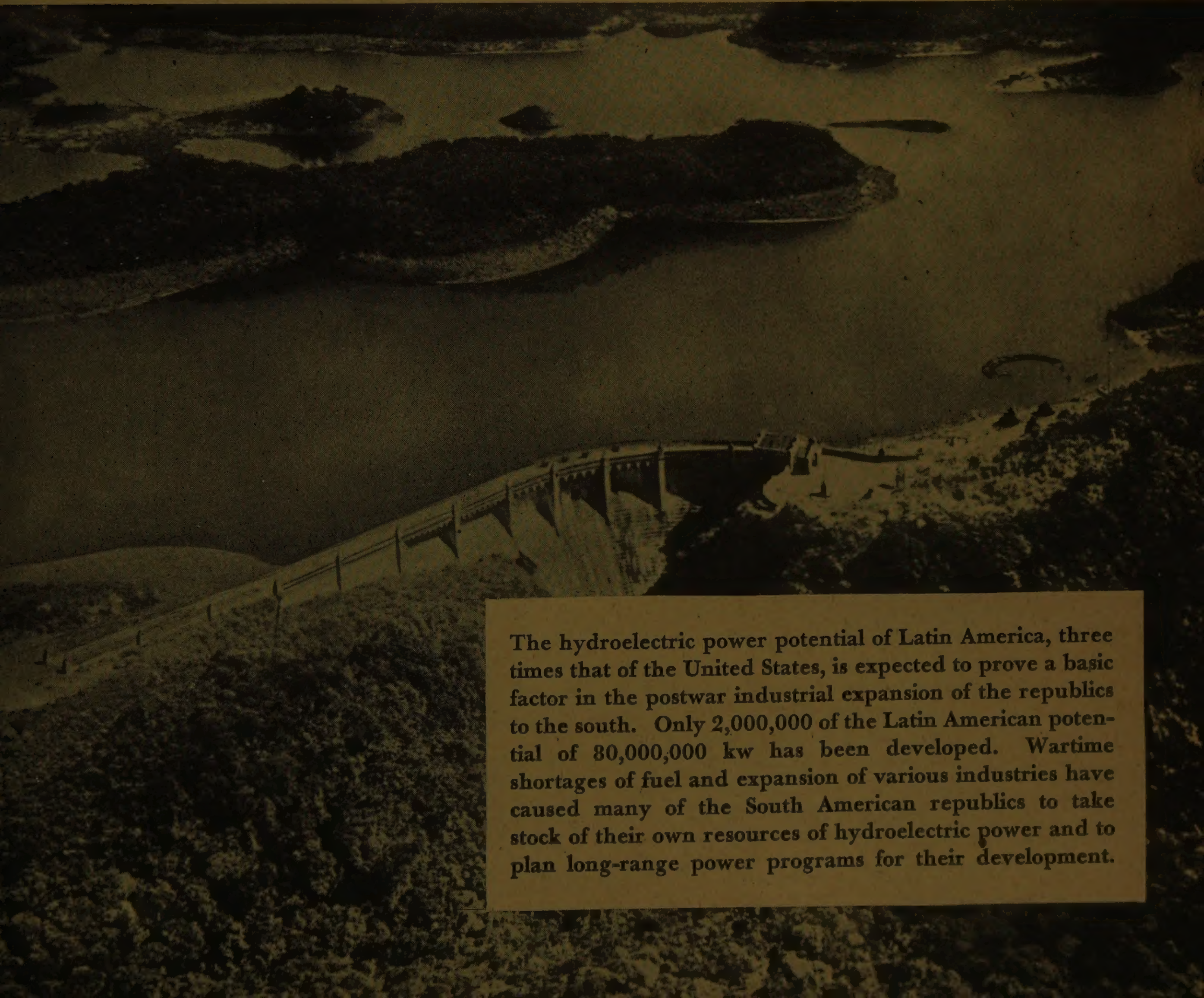
Wartime restrictions on ocean shipping and the resulting shortage of imported fuel have caused many of the South American republics to take stock of their own resources of hydroelectric power and of the possibilities for future development.

LONG-RANGE PLANNING

Development of potential power resources in Latin America is retarded now by the difficulty of importing equipment from the United States and Europe. Only power projects most essential to production of strategic materials and civilian needs get priority on equipment. Nevertheless, wartime shortages of fuel and expansion of various industries have stimulated interest in long-range power programs.

Many of these republics have large unexploited sources

Rio das Pedras Dam in the State of São Paulo, Brazil, as seen from downstream



The hydroelectric power potential of Latin America, three times that of the United States, is expected to prove a basic factor in the postwar industrial expansion of the republics to the south. Only 2,000,000 of the Latin American potential of 80,000,000 kw has been developed. Wartime shortages of fuel and expansion of various industries have caused many of the South American republics to take stock of their own resources of hydroelectric power and to plan long-range power programs for their development.

Essential substance of an article which appeared in a recent issue of *Foreign Commerce Weekly*.

Charles A. Howard is director of the Inter-American Development Commission.

Rapids in River Petrohue, southern Chile. This river drains Lake Todos los Santos; in less than 15 miles it drops 500 feet. This will be the site of the Ralun hydroelectric plant to develop 50,000 kw

of electric power—especially Brazil and the mountain republics along the Andes. Chile, which is 2,600 miles long, seldom more than 100 miles wide, and has mountains exceeding 20,000 feet in height, is an outstanding example of the Andean republics.

In Central America there are sites for possible hydroelectric installations, as, for example, the Lempa River in El Salvador. But since the power needs of most of these republics are relatively small at the present time, and the initial cost of hydroelectric plants and transmission lines is relatively high, the utilization of this potential power probably will await the fuller industrialization of these republics.

Mexico has many power sites, but most of them are remote from centers of population, and Mexico, blessed with an abundance of oil for fuel, has not been under the same pressure to develop its power as have some other republics. Mexico's National Electrical Commission has a large hydroelectric project now under construction at Ixtapantongo in the municipality of Valle de Bravo, about 100 miles west of Mexico City. The first of three 38,000-horsepower generators is now about to be installed.

Both Chile and Uruguay have nationalized the future production of electric power within their borders and have programs for the complete electrification of their public services, industries, and railroads. Although Uruguay is not a mountain republic, its electrification program is one of the most advanced in South America because of long efforts to be free from the necessity of importing coal and oil for fuel.

URUGUAY

Uruguay is fortunate in having a large water-power site located right in the middle of the Republic and only 150 miles from the city of Montevideo. Work on this 3,850-foot dam on the Rio Negro to impound the largest artificial lake in South America was begun in 1937. But since, on account of the war, the original European contractor could not finish the work, which included the installation of four generating units to develop a total of 121,600 kw, the job was turned over to a United States organization.

A 30,400-kw water-wheel generator (to be supplied by a United States company) soon will be installed at the Rio Negro dam, and a transmission line to the city of Montevideo will be erected, to relieve that city of some of its dependence on imported fuels.

The total cost of the Rio Negro project, including four generators, the dam, and transmission lines, is reported to be approximately $35,000,000.

This Rio Negro dam, which will impound a lake 87 miles in length and 18 miles in maximum width, is intended as an all-purpose project. It will not only supply electric power but also provide for flood control, irrigation for farm lands, and navigation to deliver farm products to the market and manufactured products to the rural areas. Few projects offer all four of these facilities.

Several other water-power and irrigation projects are included in the long-range plans of Uruguay. These are as follows:

A dam on the Quequay River just north of the city of Paysandu, to develop 8,000 kw.

A dam on the Arroyo Cunapiru in the north of the Republic to develop 10,000 kw and to serve the cities of Rivera and Tacuarembo.

A dam on the Cabollati River in the eastern region to develop 11,000 kw and to serve Maldonado, Treinta y Tres, and other communities.

Although the average rainfall of Uruguay is 50 inches a year, rainfall fluctuates between 25 and 72 inches, and there are frequent and sometimes serious periods of drought when it may not rain for months at a time. Uruguay at present is recovering from one of its worst droughts in 40 years.

CHILE

Chile's principal centers of potential hydroelectric energy, as cited in the plans of the Chilean Development Corporation, are located in the Aconcagua region to the north of Santiago, in the Rancagua region along the Rapel River just south of the capital, and in the Osorno region which includes the chain of lakes in the South.

Although the rivers of Chile are not large, they plunge down from great heights to the sea and offer sites for high-head installations. Some of the lakes are well located for power development. In some of the southern provinces the rainfall exceeds 100 inches per year. The lakes, waterfalls, and rapids of southern Chile provide many power locations for chemical plants, smelters, and other large users of cheap power. Sites for hydroelectric plants have been surveyed at Tocopilla, Copiapo, La Serena, Coquimbo, Sauzal, Ovalle, Lontue, Maule, Laja, Pilmaiquen, and El Volcan.

The Anconcagua system will be used chiefly in the production of Portland cement. This plant, together with other power stations, also will contribute to the electrification of the railroads and provide power for new industries.

At the present accelerated rate of consumption, it is estimated that the industries of Chile will consume 600,000 tons of cement per year by 1945, or nearly double the production of 1939. Chilean interests have purchased two unused cement plants in the United States which are to be dismantled for shipment and set up in the vicinity of Coquimbo, Chile.

Guillermo More, chief of the department of energy and combustibles of the Development Corporation of Chile, describes the work in the four zones of activity of his department as follows:

"*In the southern zone* in the vicinity of the estuary of Reloncavi and Puerto Monti, surveys have been made for the 'Ralun' generating plant which will use the waters of Lake Todos los Santos and will produce 50,000 kw initial power and at least 126,000 in full development. Todos los Santos is one of a chain of beautiful lakes. It is 22 miles long, 500 feet above sea level, and only 15 miles from the ast. The nearby and smaller Lake Chapo can produce 39,000 at a proposed site known as 'Canutillar.'

n the zone of Valdivia-Corral the 'Manio' plant on the San Pedro iver can produce 50,000 kw with a possible ultimate production of 5,000 kw. A 36-mile transmission line will bring the power to aldivia, and 20 miles more will bring it to Corral.

n the zone of Talcahuano-Concepción-Penco the 'Abanico' plant on the iver Laja is now under construction with an immediate potential 40,000 kw and a final capacity of 100,000. A 100-mile transmis- on line connects with the city of Concepción. The extraordinary onomy achieved in the construction of the plant warrants this usually long transmission line. This is the most economical of all e plants included in the program.

n the zone of San Antonio just south of the city of Santiago, the 'Rapel' ant is to be installed on the Rapel River with an initial capacity from 60,000 to 120,000 kw. A transmission line of 34 miles will nnect it with the port of San Antonio. Work has not yet begun this dam, but the plans are far advanced."

The Development Corporation of Chile has agreed to locate the sum of 900,000,000 pesos for the construction this hydroelectric plant on the Rapel River. This, it said, will be the largest installation of its type in South merica. A part of the power will be used to electrify e State railways.

The copper plant, with a capacity of 30,000 tons of ished copper a year, which Chile recently purchased om the United States, will produce copper wire for this tional electrification program.

BOLIVIA

Bolivia, as one of the mountain republics, has large serves of hydroelectric power. Plants developing some ,000 kw are functioning at present and supplying light cities and power to the mines. But this is only a fraction the total possibilities in this field. Some authorities timate that up to 4,000,000 kw could be developed in this public on the eastern slope of the Andes if the power uld be used.

Lake Titicaca, it is believed, can be made to produce 0,000 kw, which is more than is now produced by ulder Dam. However, there no market for this amount power in Bolivia at the pres- t time.

A recent decree authorizes e municipalities of Bolivia organize mixed co-opera- e societies, with contribu- ons from the State and the unicipalities and from the bscribers themselves, for the ploitation of electric services. ese societies are exempt om the payment of national, partmental, and municipal xes on imports of machines d materials. The conditions enjoying these benefits are at the societies be formed as nited liability companies of -operative type, and that the vidends or interest on the ares be limited to 19 per nt per year on the actual id-up capital. The State will contribute to the foundation of the municipal electric co-operative societies' resources which represent at least 50 per cent of the municipal contribution, for which purpose there will be included the necessary apportionments in the national budget of the industry services of the Ministry of Economy.

COLOMBIA

Colombia now has a total of 346 electric plants, of which six belong to the National Government or to the departments and 199 to the municipalities, and 141 are privately owned. Together they produced 293,782,492 kilowatt-hours in 1942, at a charge of 10,817,192 Colombian pesos to consumers. The consumption of electric power in Colombia more than tripled between 1933 and 1942.

Colombia is now considering the construction of a plant in the vicinity of the city of Manizales in the Department of Caldas to serve the industries of this region, the cost to be in the neighborhood of 2,000,000 Colombian pesos.

A 12,000-kw hydroelectric plant is planned for the Paez River between Paicol and Carnicerias, Department of Huila, and another plant is planned for Florencia in the Caqueta district at a cost of 70,000 pesos. Other activities include the completion of the hydroelectric plant at Trumesque, Department of Boyaca, and the beginning of work on a station at Titiribi, Department of Antioquia.

The Empresas Unidas de Energia Electrica of Bogota are constructing a dam at Soacha, 15 miles southwest of Bogota. This dam, which is 28 meters high and 560 meters long, with a capacity of 4,000,000 cubic meters will make it possible to increase the output of this company by 60,000 kw.

A capacity of approximately 161,000 kw of electricity is produced in Colombia. Of this total, about 114,000 kw are available to 2,000,000 inhabitants of cities and only 47,000 kw to inhabitants of rural areas.

A recent Colombian law, known as the Economic Plan, authorizes the issue of 50,000,000 pesos in internal four per cent 30-year bonds, to be used, in part, for the nationalization of public-utility enterprises now privately owned.

The Lages power house looking south, São Paulo, Brazil

The services of interest and amortization are to be met by the income from the enterprises nationalized.

PERU

The Government of Peru, with the aid of an export-import bank loan, is building a big hydroelectric development at Canon del Pato on the Santa River which flows into the Pacific just north of Chimbote Bay. Work on this project was initiated a year ago by Barton Jones, an electrical engineer who was previously associated with the Tennessee Valley Authority.

The project includes the installation of five generators of 25,000 kw each, and the first two units are expected to cost approximately $4,000,000. These units are scheduled to be completed by the end of 1945. Total power potential of the Santa River is estimated to exceed 500,000 kw.

Recent discoveries of magnesium and the known coal deposits serve to high-light the variety of the minerals in this region.

To augment the electric-power supply of the city of Lima, a new dam is being built a few miles east of the city. This will increase the power-generating capacity to 91,000 kw.

The Peruvian Government has approved the construction of 11 small hydroelectric plants, but work is retarded by lack of equipment. At the end of 1942 Peru had an estimated electric-power capacity of 225,000 kw, compared with 212,000 at the close of 1940. Production of electric power in Peru has increased 37 per cent since 1939, in consequence of the growing industries.

BRAZIL

Brazil has plans to harness the great São Francisco River with a series of dams and to exploit the agricultural mineral resources—iron, gold, mica, bauxite, quartz, diamonds, and copper—of this 260,000-square-mile valley.

The São Francisco River is 1,800 miles long, and most of it is navigable through the stretches between the falls and rapids indicated below as power sites. Just below the city of Itaparica and 140 miles from the mouth of this river, the great Paulo Affonso Cataracts have a fall of 265 feet. Here a hydroelectric station is projected to develop 600,000 horsepower. Another falls just above Itaparica is said to be capable of generating 200,000 horsepower. Higher up the river near Joazeiro is a third power site, and a fourth is much higher up near Pira pora. The American Technical Mission to Brazil has suggested a survey for the development of this river similar to the one used in developing the Tennessee Valley.

Brazil also plans to electrify more of its railroad mileage, and work has actually begun on that 90-mile section of the Sorocabana Railroad which connects São Paulo, the industrial metropolis of Brazil, with the important city of São Antonio. This railroad, which is double-tracked through its entire length, is owned by the State of São Paulo. This electrification project will cost over $10,000,000 and is expected to take about three years to finish.

The line is meter-gauge—that is, the rails are 39 inches apart as compared to $56^{1}/_{2}$ inches on the United States railroads. The present rails are being replaced by heavier ones, and the 80-ton locomotives now in use are to be replaced by 180-ton electric locomotives, said to be the heaviest electric locomotives ever built for meter-gauge tracks. Ten of these locomotives have been ordered from the United States. For suburban service, trains of three coaches each will be used, orders for which have also bee placed in the United States.

Brazil has abundant water power accessible to this line which in the past has used imported coal and firewood All available wood has been cut within several miles o either side of the line, and wood must now be hauled fo considerable distances. The Sorocabana Railroad has total length of 1,316 miles and serves the Pocos de Calda region of southern Brazil which is an important center fo bauxite and other minerals. One branch of the line con nects with the port of Santos.

Brazil now has a total of 1,343 electric-power installa tions of various types supplying light and power to 2,17 communities. In 1940 Brazil had an installed capacity c 993,742 kw, of which 732,000 kw represented hydroelectri plants and 193,742 steam plants. Nearly all the hydro electric power at present produced in Brazil is concentrate in the industrial State of São Paulo and in Rio de Janeiro

ARGENTINA

The Argentine Republic finds itself in a relatively dis advantageous position so far as the development of hydro electric power is concerned, because both the populatio and the industry of this Republic are concentrated in th Atlantic seaboard area, in and around the Province c Buenos Aires, while the water-power sites are severa hundred miles away in the foothills of the Andes.

Argentina at present has 700,000 kw of installed electri power, of which 542,000 kw are in the Province of Bueno Aires. The Republic has only 31,000 kw of hydroelectri power, nearly all of which is in the Provinces of Mendoza Cordoba, and Tucuman.

As part of the national public-works program, Argentin plans to build a number of irrigation projects impoundin large lakes in the northern and western region. Whereve possible this water also will be used to produce electri power, though power is secondary to irrigation.

CONTROL BY OWN NATIONALS

A number of the South American countries have ind cated their desire to have their electric-power faciliti controlled by their own nationals. They desire foreig equipment and foreign technical assistance more tha foreign capital in developing their water-power resources.

If they develop their water power with their own capit and distribute the power to their principal consumptio centers at a reasonable cost per kilowatt, their econom positions will be materially strengthened by the extent which their foreign-exchange requirements for the purcha of imported fuel will be reduced, as well as by the adva tages which will accrue from the use of the power itself.

There should be an opportunity for engineers and man facturers in the United States to participate on a mutual advantageous basis, in these large programs of the Sou American republics for water-power developments.

The hydroelectric power potential of Latin Americ three times that of the United States, is expected to prove basic factor in the postwar industrial expansion of the r publics to the south. Only 2,000,000 of the Latin Ame can potential of 80,000,000 kw has been develope Brazil—which ranks fourth to the Soviet Union, the Unit States, and Canada in potential hydroelectric power—h a potential of 19,000,000 kw, which, if realized in industri energy, would go far toward providing the power need for industrializing that nation.

Are All the Basic Problems Solved in Electric Machinery?

M. M. LIWSCHITZ
MEMBER AIEE

Development of electric machinery is far from static and will keep step with progress in other technical fields in the postwar period, says this author. He discusses the specific and the common problems of each type of rotating electric machine, including the method of teaching their operation, and outlines the probable direction theoretical and engineering research will take toward their solution.

THE OPINION prevails, not only among students and younger engineers but also among older engiieers who are not familiar with the field of electric nachinery, that the electric machine reached the peak f its development years ago and that no further progress s possible in this field. It will be shown in the following rticle that this opinion is wrong, that the improvement f the electric machine is steadily progressing, and that he development of the electric machine is far from its eak.

Development in engineering means better and better itilization of the active material; in the electric machine t means better utilization of he core iron and the copper. The higher the output per init volume, the more the ictive material is utilized. 'arallel with the reduction f the active material must o the reduction of the inictive material, that is, the naterial in the frame, the pider, the bearings, and so orth.

Figure 1 shows the reduction of the active weight of a ,000-hp induction motor with 1,200 rpm for the period etween 1910 and 1935. The reduction of the weight f the inactive material in this instance is about the ame. Since 1935, further progress has been made. The question is: "Can the extent of the progress made etween 1910 and 1935 be repeated in the future?"

The answer is: "Yes!" It will be achieved step by tep by solving the problems which handicap the further itilization of the materials, and, also, by introducing new levelopments. These possible new developments will be liscussed later on. First, some old as well as new problems will be outlined, the solution of which will open the vay for further development of the electric machine.

Electric machines can be divided in two main groups. The first group includes the induction motors and the ynchronous machines; the second group includes the l-c machines and the a-c single-phase series motor, that s, the transportation motor. Between these two groups ie, as connecting members, the rotary converters and he three-phase a-c commutator machines.

The main feature of the first group is that its armature ield is uniquely determined by the load. For any given oad there is a fixed magnitude of the armature field and a fixed position of this field relative to the primary field. In these machines it is not possible to cancel the effect of the armature field by a compensating winding. A common characteristic of machines in this group is operation on the transformer principle.

The main feature of the second group is that the position of the armature field is independent of the load; it is determined solely by the position of the brushes on the commutator. Here, the effect of the armature field can be cancelled out by a compensating winding. In the a-c transportation motor, moreover, this cancellation is unavoidable.

We shall consider some of the actual problems of the first group; then, some of the actual problems of the second group; and, finally, some of the problems common to all electric machines.

INDUCTION MOTORS

Starting with the induction motor, one has to consider, at first, the harmonics produced by the windings in the air gap of the machine. These harmonics give rise to the following troubles: asynchronous torques, synchronous torques, and mechanical vibrations which produce noise. The asynchronous torques cause dips in the torque-speed curve of the machine which may prevent the motor from attaining normal speed. The synchronous torques cause cusps in the torque-speed curve; a large synchronous cusp at standstill may prevent the motor from starting, and a large synchronous cusp during running may prevent the motor from reaching its normal speed.

Table I shows the harmonics produced by the stator, as well as by the rotor, of a four-pole squirrel-cage induction motor with 72 slots in the stator and 58 slots in the rotor. The first column represents the harmonics produced by the stator winding; the harmonics contained within the square are the dangerous slot harmonics. Each stator harmonic produces rotor harmonics of the order shown in the horizontal rows of the table. The determination of the order of these harmonics is given in the accompanying formula, where Q_2 is the number of rotor slots and K_2 is any positive or negative integer including zero.

In the first column of the rotor harmonics, that is, in the column that corresponds to $K_2=0$, the order of the rotor harmonics is the same as that of the stator har-

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M. Liwschitz is with the Polytechnic Institute of Brooklyn, Brooklyn, N. Y., nd is also consulting engineer for Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

monics. Each of these rotor harmonics produces with the corresponding stator harmonic an asynchronous torque. All other rotor harmonics produce synchronous torques.

By using a proper slot combination, that is, a proper ratio between the number of stator and rotor slots, one is able to avoid entirely the synchronous cusps and thus insure the starting of the motor. One cannot avoid the asynchronous torques, but they can be reduced to a permissible amount by using a proper slot combination and a proper coil pitch.

The choice of a proper slot combination also introduces the problem of stray load losses; that is, of additional losses in the iron and in the copper due to the harmonics. Only a few years ago one could find on the market induction motors with stray load losses that were relatively high and that necessarily caused an appreciable reduction of the efficiency. We have learned how to reduce this extra loss to a small amount even in small machines, thereby increasing the efficiency of the induction motor considerably.

The third trouble produced by the harmonics, that is, the mechanical vibrations connected with noise, hinders perfection in the induction motor, especially in machines with fabricated frames.

In the electric machine, the lines of the magnetic induction pass radially through the gap. Therefore, at any point in the gap, there will be a radial force that is proportional to the square of the induction. Since the induction, at any point, is equal to the sum of the stator harmonics and the rotor harmonics, the evaluation of this quantity shows that there are forces in the gap produced by the stator harmonics only, forces produced by the rotor harmonics only, and forces produced by the stator harmonics in co-operation with the rotor harmonics.

A simple mathematical calculation makes it possible to represent these forces as stationary forces and traveling force waves. Like the rotating field that produces the torque of the machine, the force waves travel in the gap around the stator without change in amplitude. Since there are many harmonics produced by the stator and rotor, there will be in every machine many traveling force waves with different numbers of poles.

The kind of distortion of the stator core caused by a stationary force is shown in Figure 2. This force has no poles; it is constant around the stator at any instant, but it changes its value with a certain frequency from a positive maximum to a negative maximum. The result is a periodical increase and decrease of the core diameter. The kind of distortion caused by force waves with two poles, four poles, and six poles is shown in Figure 3. Whereas the two-pole force wave flattens the stator core, the four-pole force wave makes it oval. The six-pole force wave, as well as the force waves with a greater number of poles, makes the stator core polygonal. The oval or the polygon is not at standstill, of course; it travels around the machine together with the force wave that produces it.

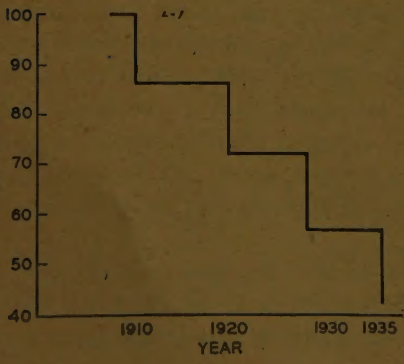


Figure 1. Reduction in weight of the active materials in a 1,000-horsepower six-pole 1,200-rpm induction motor

Table I. Slot Harmonics in a Four-Pole Squirrel-Cage Induction Motor With 72 Slots in the Stator and 58 Slots in the Rotor

Stator n	Rotor $m=K_2\frac{Q_2}{p}+n$, $Q_2=58$				
	$K_2=0$	$K_2=+1$	$K_2=-1$	$K_2=+2$	$K_2=-2$
+1	+1	+30	−28	+59	−57
−5	−5	+24	−34	+53	−63
+7	+7	+36	−22	+65	−51
−11	−11	+18	−40	+47	−69
+13	+13	+42	−16	+71	−45
−17	−17	+12	−46	+41	−75
+19	+19	+48	−10	+77	−39
−23	−23	+6	−52	+35	−81
+25	+25	+54	−4	+83	−33
−29	−29	0	−58	+29	−87
+31	+31	+60	+2	+89	−27
−35	−35	−6	−64	+23	−93
+37	+37	+66	+8	+95	−21

☐ Slot harmonics.

Whereas the stationary forces produce radial vibrations of the core, the traveling force waves produce flexural vibrations. The consequence of the mechanical vibrations is noise.

The stator is, in general, stiffer with respect to short-wave distortion than to long-wave distortion. This means that the force waves with a small number of poles have to be avoided; especially dangerous is the two-pole force wave.

The frequency of the noise produced by the harmonics is of great importance. As mentioned before, there exist in the gap force waves produced by the stator harmonics only, force waves produced by the rotor harmonics only, and force waves produced by the stator and rotor harmonics together. It can be shown easily that the frequency of the noise produced by the stator harmonics only is equal to twice the line frequency. This noise usually is not disturbing. The noise produced by the rotor harmonics only has double line frequency or a relatively high frequency and, also, usually is not disturbing. However, the noise produced by the stator harmonics in co-operation with the rotor harmonics may be very disturbing, as the frequency is approximately the slot frequency, that is, between 800 and 2,000 cycles.

The noise may become intolerable when the natural frequency of the core, or of any other mechanical part which is connected with the core, is the same as the frequency of the vibrations produced by the harmonics (resonance). Machines with fabricated frames are especially sensitive to the forced vibrations produced by

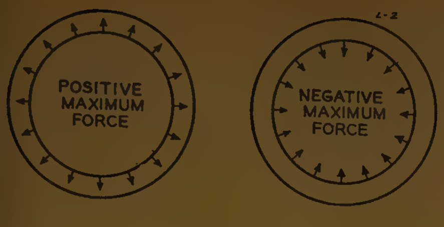


Figure 2. Distortion of the stator core caused by a stationary force

the harmonics. The cover of such machines is usually a relatively thin plate that behaves, with respect to vibration, as a membrane having many natural frequencies. Since there are many force waves with different frequencies, the possibility exists that one or more forced frequencies will coincide with the natural frequencies of the membrane. One cannot avoid the harmonics and the force waves produced by them. By proper chording of the stator winding one can reduce the harmonics of lower order, and by proper skewing the influence of the dangerous slot harmonics can be reduced, but in the case of resonance, even a very weak harmonic may produce a heavy noise. The noise problem could be brought nearer to its solution if one were able to determine the natural frequencies of the stator. The stator is a complicated structure consisting of the core laminations and bolts or bars which bind the laminations together, of the frame, cover, shields, and so forth. Here is a difficult problem that has to be solved yet, especially with respect to flexural vibrations.

The natural frequency of the stator is independent of the speed of the motor, but the forced frequencies produced by the harmonics depend on the speed. Therefore, it is more difficult to avoid resonant points in a machine with variable speed than in a machine with constant speed. In Figure 4, the axis of abscissas represents the number of force poles (or nodes), and the axis of ordinates, the natural frequencies. The curve represents the natural frequencies of the stator. The vertical lines represent the frequencies for different force waves having 6, 12, 16, 24, and 32 force poles. The upper point of each vertical line corresponds to the normal speed of the motor; the point at the bottom of each vertical line corresponds to the lowest speed of the motor. If the machine ran at its normal speed only, resonance between the forced and natural vibrations would not occur. Since the rotor speed is variable, the forced frequency of each force wave goes through a wide range and the intersection points will give resonance.

Figure 4 refers to an induction motor with speed variation over a wide range. The a-c variable-speed drive for smaller output is accomplished by a-c commutator motors and will be discussed later. The a-c variable-speed drive for large output uses the induction motor as a primary machine, and the methods which are used are neither simple nor inexpensive.

There are 4 different methods to vary the speed of an induction motor having fixed stator frequency:

1. By using a rotary converter which is connected to the slip rings of the rotor of the induction motor.
2. By using an a-c commutator machine which is connected to the slip rings of the induction motor.
3. Through doubly feeding, that is, stator and rotor of the induction motor are connected to two sources of different frequencies.
4. By a rheostat in the rotor circuit.

The first and second methods are based upon the fact that a voltage which is in phase with the line voltage, or opposite to it, will change the speed of the induction motor when impressed on its rotor. When it is desirable that the induction motor does not lose its character as an induction motor, that is, its ability to change speed with the torque, the secondary machine must be able to adjust its frequency automatically to the slip frequency of the induction motor. The rotary converter and the three-phase commutator machine are able to effect this adjustment. This is one of the reasons why the rotary converter and a-c commutator machines have been used relatively often for speed control of the induction motor.

The scheme of connection between induction motor and rotary converter is shown in Figure 5. When the torque on the shaft of the induction motor must increase with decreasing speed, a d-c machine is necessary on its shaft. When the torque must decrease with decreasing speed, two d-c machines and a synchronous machine or induction motor are necessary. Both arrangements are known under the name of Kramer–Cascade. The variation here is possible only below synchronism. The speed can be reduced 30 to 40 per cent of the normal value.

Figure 6 shows the induction motor in connection with the rotor-excited a-c commutator machine. The stator of the commutator machine has a compensating winding only. The excitation is delivered from the line to the rotor winding through slip rings. The compensating winding in series with the commutator is connected to the slip rings of the induction motor. Speed variation is possible above, as well as below, synchronism. The machine has no interpoles. The commutation therefore, is sensitive, and limits the input of this machine to approximately 200 kva.

Figure 7 shows the scheme of the Scherbius machine. In this machine, the three-phase system is resolved into three single-phase systems. The purpose is to make space for interpoles. The compensating winding is located in the poles. The windings of this machine are not simple. Each pole has three compensating windings, one for each phase. The interpole has three windings, two for the elimination of the electromotive force of self-inductance, and the third to reduce the transformer electromotive force.

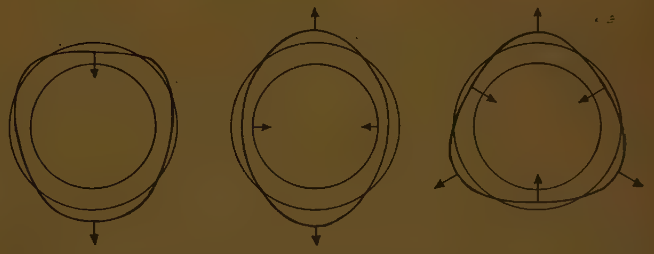


Figure 3. Distortion of the stator core caused by (left to right) two-pole, four-pole, and six-pole traveling force waves

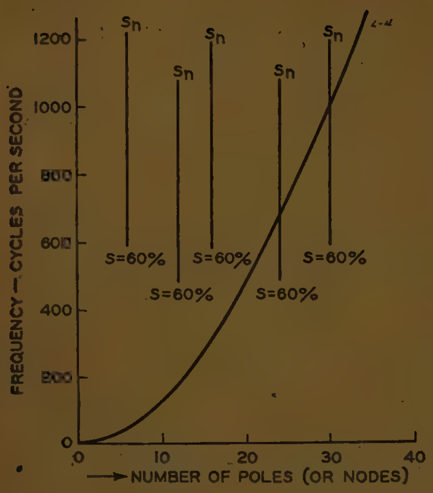


Figure 4. Forced frequencies in induction motors having wide speed variations. Intersections with the stator natural-frequency curve indicate points of resonance

Whereas the rotor-excited a-c commutator machine must be mechanically coupled with the induction motor, this is not required for the Scherbius machine. Figure 8 shows the Scherbius machine driven by an induction motor, but it can also be driven by a separate synchronous machine. The field winding is connected to the slip rings of the induction motor. The scheme, as shown in Figure 8, is applicable when speed variation below synchronism only is required. For speed variation above synchronism, a small frequency changer coupled with the induction motor is necessary, as shown in Figure 9. Since the Scherbius machine has interpoles, it can be built for a much larger input than the rotor-excited a-c commutator machine. Considering commutation, the Scherbius machine can be used for a speed variation of plus or minus 30 per cent of the normal speed.

When a speed variation over a wide range for a large induction motor is required, neither the Kramer-Cascade nor the Scherbius machine can be used. In this case the arrangement shown in Figure 10 has been applied. The rotor of the induction motor is connected to a synchronous machine which is driven by a d-c machine. Thus, the induction motor is doubly fed. It has the character of a synchronous machine since its speed is uniquely determined by the frequency of the line and the frequency of the synchronous machine. Besides the synchronous machine and the d-c machine, a second d-c machine and a second a-c machine (a synchronous machine or induction motor) are necessary. Speed variation is possible below synchronism only.

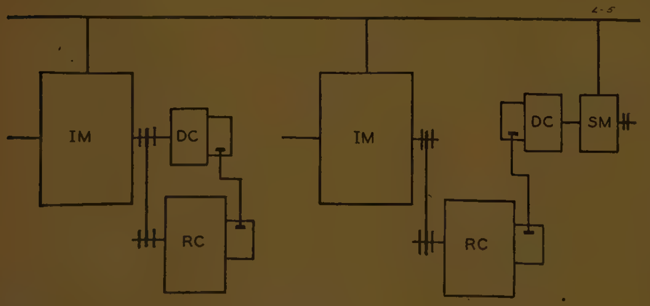


Figure 5. Schematic diagram showing the use of a rotary converter for varying the speed of a large induction motor

This arrangement for speed variation is economical as well as the arrangements mentioned before, since the slip energy is applied to increase the torque of the motor or is sent back to the line. Speed control by a rheostat in the rotor circuit is uneconomical, since the slip energy is lost. However, in some cases the latter method is preferred to the others for its simplicity.

It cannot be said that the solutions for speed variation of the induction motor are simple. When the solution is simple, as in the case of the rotor-excited a-c commutator machine, the commutation is sensitive and the range of speed variation is limited.

SYNCHRONOUS MACHINES

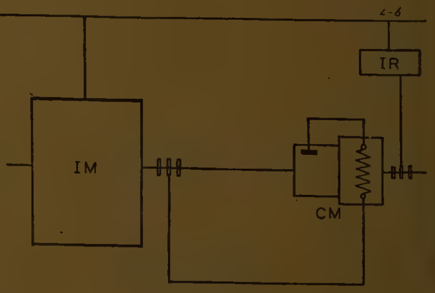
We turn, now, to the synchronous machine. The influence of the harmonics here is not so great as it is in the induction motor because of the larger air gap of the synchronous machine. Yet, in the salient-pole machine, the harmonics may produce troublesome noise. The investigation of the noise produced by the harmonics is more difficult here than in the induction motor, because here there is another source of noise, namely, the noise produced by the pole tips and the stator teeth. A study of the noise produced by the harmonics in salient-pole machines is necessary.

An important problem for the synchronous generator with salient poles is the telephone-interference factor. This factor depends on the shape of the pole head, on the saturation, on the stator slots, and on the damper winding. The existence of a damper winding is usually connected with an increase of the telephone-interference factor. Sometimes a little change in the distribution of the damper bars reduces the telephone-interference factor to one half or even a third of its value. An investigation of the influence of the different quantities on the telephone-interference factor is important for the medium-size salient-pole machines. The usual means used to reduce the telephone-interference factor, such as the increased gap, the sinusoidal gap, or reduction of the saturation, handicaps the development of the synchronous machine.

The damper winding of a salient-pole machine is an asymmetrical winding. The damper bars are arranged in the pole head only. There are no bars in the interpolar space. This makes any calculation in which the damper winding plays a part very difficult.

Investigation of the salient-pole machine is possible only on the basis of the two-reaction theory. This theory considers separately the direct axis and the

Figure 6. Schematic diagram showing the use of a rotor-excited a-c commutator machine for varying the speed of a large induction motor



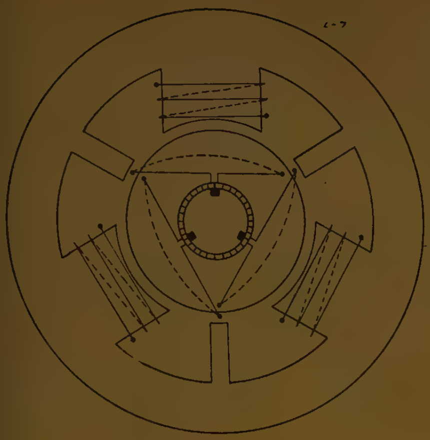


Figure 7. Schematic diagram of the Scherbius machine

quadrature axis. Calculations on the synchronous machine are based on the constants of its windings in both of these axes. There still exists no method for determining the constants of the damper winding with sufficient accuracy.

This hampers the accurate determination of the starting performance of the synchronous motor, of the subtransient reactances in both axes, of the damping torque, and of the synchronizing torque.

The starting torque, the starting current, and the pull-in torque, depend primarily on the constants of the damper winding. The accuracy of the calculation of these quantities on the basis of our present knowledge is plus or minus 15 per cent. When guarantees have to be met, the designer calculates with a certain margin, and margin usually means an increase of the material in the machine. Thus, much more work has to be done on the solution of the starting problem of the synchronous motor.

In order to reduce the manufacturing costs, the connection of the damper rings between the single poles often is omitted. The current distribution in the damper bars of each pole, in this case, is independent of that of the neighbor poles, and, as a result, circulating currents flow between the end bars, through the end laminations of the poles, and through the rotor core. Of course, this makes the computations connected with the damper winding much more difficult.

It has been observed that an unbalanced short circuit in the line may cause high overvoltages, and it has been found that the principal factor for determining the magnitude of these overvoltages is the ratio between the subtransient reactance in the quadrature axis and the subtransient reactance in the direct axis.

When the damper segments between the different poles are disconnected, the subtransient reactance in the quadrature axis is, of course, much larger than in the case when they are connected and, also, much larger than the subtransient reactance in the direct axis. In long machines, the circulating currents between the poles reduce the subtransient reactance in the quadrature axis, but, still the ratio is considerably larger than one. A complete solution of this problem will be possible only when more theoretical work is done on the damper winding with respect to its resistance and reactances in both axes.

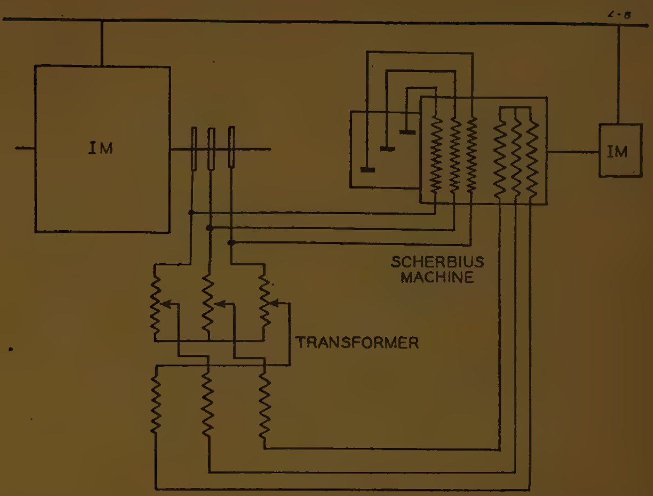


Figure 8. Schematic diagram showing the usual connection between the induction motor and the Scherbius machine

For investigation of stability problems in which the synchronous machine is involved, an exact knowledge of the damping torque and synchronizing torque produced by it is necessary. Although the two-reaction theory in its final form gives the possibility of calculating these torques, even when the primary resistance has to be taken into account, the accuracy of the calculations depends on the constants of the machines. The constants involved again are the constants of the damper winding and, in addition, the synchronous reactances of both axes. These latter depend on the saturation of the machine and on the load. There exists no exact method of calculating the synchronous reactances that takes into account the saturation with satisfactory accuracy, and further theoretical work has to be done here too.

D-C MACHINES

Proceeding to the d-c machine, we meet an old problem that is still new, namely, that of commutation. The commutation is not only an electrical problem; it is a mechanical problem and a chemical problem as well. The construction of the brush holder, the vibrationless running of the brushes and commutator, the brush pressure, and the chemical composition of the brushes are all of primary importance. However, if we limit our considerations to the electrical problem only, we must say that this problem has not been entirely solved. The gap of the interpole and the ampere turns of the interpole can be calculated to a satisfactory accuracy, but not so accurately that changes of the gap on the test floor can be avoided. On a certain percentage of d-c machines, the interpole gap has to be adjusted after the machine has been assembled, and this means a waste of time and money.

One of the difficulties lies in the determination of the electromotive force induced in the short-circuited coil through self-inductance and mutual inductance. The exact determination of the coefficient of self-inductance is not simple. Much more difficult is the determination of the coefficient of mutual inductance. But even if we

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were able to calculate these coefficients with satisfactory accuracy, the solution of the problem requires that the current in the short-circuited coil be determined as a function of time. This leads to complicated differential equations that can be solved under simplifying assumptions only.

For this reason, the whole theory of commutation is simplified for practical use. The coefficient of self-inductance and the coefficient of mutual inductance are combined as one factor, and for the current variation as a function of time an average value is assumed. The formula for the electromotive force induced in the short-circuited coil through self-inductance and mutual inductance is

$$e = 0.507 l_i N_c V_a A \xi 10^{-8} \text{ volts}$$

where l_i is the length of the interpole, N_c is the number of conductors per commutator bar, A is the number of ampere conductors per unit circumference of the armature, V_a is the velocity of the armature and ξ is a factor which takes into account the coefficient of self- and mutual inductance. A is calculated by using the load current of the armature.

Although the formula is simple, it includes all of the principle factors which influence the commutation. We see from this formula that if it were possible to reduce the factor ξ, the magnitude of A could be increased. The output of the machine is directly proportional to A and, thus, the output could be increased. Or, instead of increasing the magnitude of A, the armature velocity V_a could be increased with a decrease in ξ. This, again, means an increase in the output of the machine.

A decrease of the factor ξ can be achieved through reduction of the slot leakage. An arrangement to achieve this is shown in Figure 11. A solid copper bar of L shape is put into the slot. The reduction of the slot leakage is considerable but, unfortunately, losses arise in the L bar that reduce the efficiency. The conditions are similar to those which exist in the squirrel-cage rotor with deep bar. Some large European d-c machines have been provided with the L bar.

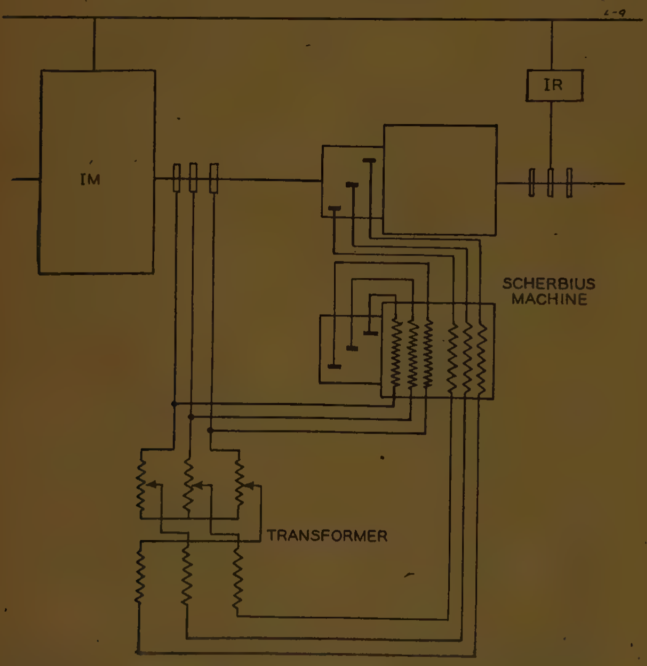


Figure 9. Schematic diagram showing the use of the Scherbius machine for speeds above synchronism

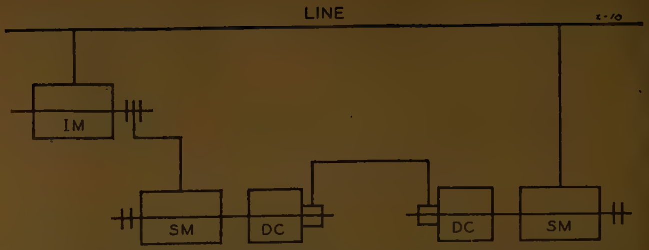


Figure 10. Schematic diagram of doubly fed induction motor for wide speed variations below synchronism

Figure 12 shows another arrangement to reduce the slot leakage. This arrangement is not so effective as the L bar with respect to the reduction of the slot leakage, but the losses are smaller. Two short-circuited coils are put into the slot so that the lower conductor of each coil is at the bottom of the slot, whereas the upper conductor lies at the top of the slot directly under the edge. In order to reduce the losses, the conductor consists of some copper wires of small diameter or of copper sheets. Thus, the conductors are flexible and facilitate the assembling of the winding. This method of reduction of the slot leakage also has been used in Europe. As we see, improvements in the commutation of the d-c machine are possible, and undoubtedly will be made. A further study of the commutation problem is necesary.

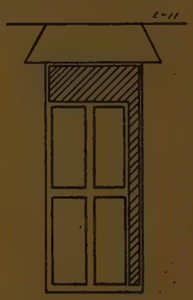


Figure 11. Use of an L-shaped copper bar to reduce slot leakage

A-C COMMUTATOR MOTORS

In a-c commutator motors the commutation plays a much greater part than in the d-c machines, because of the fact that in the short-circuited coil an additional electromotive force is induced, namely, the transformer electromotive force. While the electromotive force of self-inductance is proportional to the current and to the speed of the machine, the transformer electromotive force is proportional to the flux and to the line frequency. A simple interpole winding is not able to correct for these two electromotive forces, because they are produced by different physical quantities. Special arrangements are necessary to meet both troublesome electromotive forces.

The transformer electromotive force cannot be cancelled through transformation by an auxiliary flux. Like the electromotive force of self-inductance, the transformer electromotive force must be cancelled by an electromotive force that is induced in the short-circuited coil through rotation in an auxiliary field. This is possible at a single speed only. At all other speeds a residual electromotive force will exist in the short-circuited coil.

The conditions are especially bad at standstill. There is no reduction at all of the transformer electromotive force at standstill. This situation leads to a reduction of the flux and, where possible, also to a reduction of the line frequency, as in the transportation motor. Thus, due to the transformer electromotive force, the a-c commutator motors are oversized in comparison with the induction motor or synchronous motor of the same output.

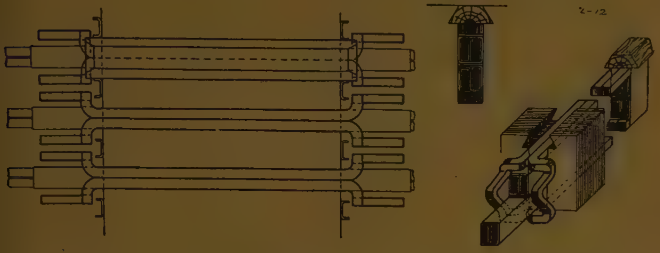


Figure 12. Method of reducing slot leakage by use of short-circuited coils

The best existing a-c commutator motor, as far as the commutation is concerned, is the single-phase series motor (the transportation motor). This is so because the transportation motor has an interpole winding and a special arrangement to reduce the transformer electromotive force: a resistance parallel to the interpole winding shifts the current in it in such a manner that one component of the interpole flux takes care of the electromotive force of self-inductance while the other component takes care of the transformer electromotive force.

In three-phase commutator motors one must consider the electromotive force induced in the short-circuited coil by the rotating field instead of the transformer electromotive force.

Figure 13 shows the scheme of the three-phase series motor. A transformer is necessary between the stator and commutator. Torque and speed are changed through brush shifting.

Two kinds of the three-phase shunt motor are on the market—the stator-fed and the rotor-fed motor. Figure 14 shows the scheme of the stator-fed three-phase shunt motor. The stator has a main winding connected to the line and an auxiliary winding connected to the commutator. A small induction regulator is provided in order to change the armature voltage and speed.

The rotor-fed three-phase shunt motor is shown in Figure 15. The rotor has two windings, one connected with the slip rings, the other connected with a commutator. The slip rings are connected to the line.

The operation of this motor is the same as that of an induction motor with the primary winding in the rotor, the secondary winding in the stator, and a commutator machine that impresses a voltage on the secondary winding.

In order to change the magnitude of the impressed voltage, two sets of brushes are necessary on the commutator, shifted, with respect to each other, in the axial direction. The beginnings of the three stator phases are connected to one set, the ends to the other set. When the brushes that belong to the same phase are in the same line, that is, when they are located on the same commutator bar, the impressed voltage on the stator is zero. In this position of the brushes, the machine behaves as a normal induction motor. By moving one brush set with respect to the other, in one or the other direction, it is possible to change the magnitude and direction of the impressed voltage and, therefore, the speed also.

The two rotor windings shown in Figure 15 can be connected to a single winding.

As we see from the schemes of the three-phase motors, nothing is provided to eliminate the electromotive force of self-inductance in the short-circuited coil. An arrangement to reduce the second electromotive force of the short-circuited coil is not possible because of the fact that we are dealing with a rotating field. Hard brushes, in this case, are the single remedy against bad commutation. An improvement in the commutation can be achieved by putting resistance between the risers and the winding or special winding connected to the commutator, but this is neither simple nor economical.

Because of the lack of arrangements for improving the commutation, the three-phase a-c commutator motor is limited to a small output. For a larger output it becomes sensitive with respect to commutation.

Many thousand a-c commutator motors for smaller output have been in satisfactory operation for years. Yet the a-c variable-speed drive is still awaiting a solution.

PROBLEMS COMMON TO ALL ELECTRIC MACHINES

We proceed, now, to the problems common to all electric machines. These are the loss problem and the cooling problem.

Losses. There are four kinds of losses in the electric machine—copper, iron, windage, and friction losses. The copper-loss problem can be considered solved. We are able to build even large machines with approximately ten per cent extra loss in the copper. In small machines, the extra copper loss is small because of the small size of the conductor. In medium and larger machines, a proper stranding reduces the losses. In large machines, special means may be necessary to keep the extra loss down. These means are the group transposition, the inverted-turn transposition, the twisted-lead transposition, or, finally, the Roebel transposition, which is made up inside the slot, whereas the three other kinds of transposition are made in the end winding or in the leads.

Great improvement can be expected in the iron-loss problem through the use of cold rolled steel. Much progress has been made in transformers by this means. However, there is a factor that limits the use of this steel in electric machines. Its good properties—high magnetization and low losses when magnetized in one certain direction only—make it adaptable to the stationary field of the transformer. But, in the electric machine, with rotary magnetization, that is, magnetization in all directions, the cold rolled steel must be equalized for all directions before it can give here the same good results as in the transformer.

Not all iron losses in the electric machine are due to the main flux. A large part is due to mechanical rotation. If we consider, for example, the no-load losses of an induction motor, approximately one third is produced by the main flux and two thirds through mechanical rotation. This ratio, one third to two thirds, depends on the slot combination chosen and is valid for a well-designed motor. At no load, a badly designed motor may have the ratio between the iron loss due to the main field and the iron loss due to the mechanical rotation, one to six, and more. In general, in the electric machine, the iron losses depend not only on the quality of the iron, but also on the design. However, in a well-designed machine, an improvement in the quality of the iron will reduce the iron loss. Progress of the same kind as in the transformer can be expected in the electric machines, also.

Not very much attention has been paid to the efficiency of the fans in electric machines except those in turbogenerators, where the friction losses play a great part. Improvements in the fans of all other machines can be made. However, much more important than the efficiency of the fan, is the air distribution produced by it. The air distribution in the machine is of primary importance for its cooling.

Heating. The heating problem is still far from its solution. The electric machine is a body composed of many parts having different heat conductivities. It is not a solid body; it is divided by air ducts into sections. The heat has to be transferred to the air in these vents, to the air at the end windings, and to the air at the cylindrical surfaces of the core iron. The heat-transfer constants at all these spots have a great influence on the cooling of the machine. Since the heat conductivities of all insulating materials used in the machine are involved, a dozen different heat conductivities, and at least four heat-transfer constants have to be taken into account for the solution of the heat problem. These four heat-transfer constants are those of the end windings, of the coils in the vents, of the iron in the vents, and of the iron in the gap of the machine. All heat-transfer constants depend mainly on the air velocity. For example, the heat-transfer constant of the end winding is equal to 0.025 watt per square inch per degree centigrade when the air velocity between the end windings is equal to 590 feet per minute, and to 0.038 watt per square inch per degree centigrade when the air velocity is equal to 1,180 feet per minute.

When the width and depth of the coil are small in comparison to the length of the conductor, the heat problem can be treated as a one-dimensional problem, that is, it can be assumed that there is no temperature change in the transverse section of the conductor, and that a temperature change exists only in the axial direction of the conductor. In large machines with deep slots, the heating problem of the winding must be treated as a two-dimensional problem.

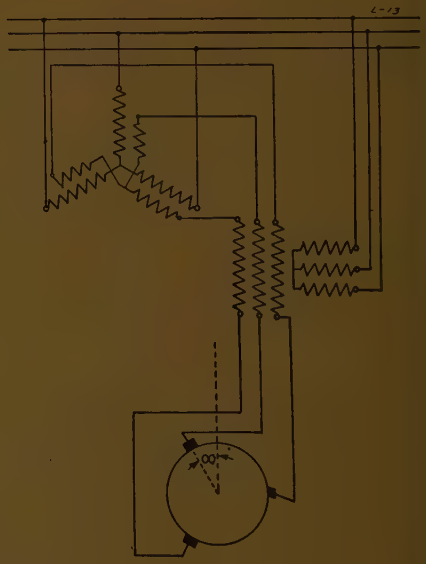
The solution of the heating problem leads to a system of many simultaneous differential equations. Yet, the problem can be solved, and it will be solved. Competition after the war will force engineers to solve some of the problems they have postponed.

How important the solution of the heat problem is can be seen from Figure 16. This figure relates to a three-phase salient-pole synchronous machine for 1,600 kva, 6,600 volts, and 24 poles. Of the total losses in the stator, 41 per cent are iron losses, and 59 per cent are copper losses. There are two ways through which iron losses can be transferred to the air. These are the inner cylindrical surface of the stator core, and the vent and finger plates. Approximately 40 per cent of the iron losses are absorbed by the air in the gap and 60 per cent of the iron losses are absorbed by the air in the vents.

There are three ways through which copper losses can be transferred to the air. These are via the end windings, the coil portions which lie in the vents, and the coil portions which lie in the core iron. We see from Figure 16, that approximately 55 per cent of the copper losses are absorbed by the air that surrounds the end windings, approximately 12 per cent of the copper losses are absorbed by the air which goes through the vents, and the remaining 33 per cent, is transferred to the core iron. The larger the part of the copper losses that is transferred to the iron, the lower will be the temperature of the copper at the hottest spot, which is the center of the middle stack of laminations, and the lower will be the average temperature rise of the winding as determined by resistance test.

It is wrong to leave the cooling of the winding mainly to the end windings, because this leads to hot spots.

Figure 13. Schematic diagram of a three-phase series motor



It is still worse to transfer heat from the iron to the winding, thus forcing the end windings to transfer to the air the total copper losses and a part of the iron losses.

A correct distribution of the heat in the winding between the three parts that transfer this heat is of great importance for the further development of the electric machine. But, only the solution of the heat problem will enable us to make this distribution in a desirable way.

INSULATING MATERIALS FOR HIGH TEMPERATURES

There is another prospect for further progress in electric machinery. This is the improvement of insulating materials with respect to their ability to resist higher temperatures. Tests are now in progress on materials that are able to withstand very high temperatures. Since the permissible temperature rises in electric machines are determined by the insulation materials only, a higher output for the same weight will be achieved by new materials. The higher the temperatures that can be admitted, the more one will have to know about the heat distribution and heat transfer in the machine. Study of the heating problem must go hand in hand with an increase of the temperatures.

METHOD OF TEACHING ELECTRIC MACHINERY

As we have seen, many problems in electric machinery, both old ones and new ones, are awaiting solution. We have seen further, that there are possibilities for an increase of output at the same weight, or for a decrease of weight at the same output. Both mean better utilization of the material. We can expect the postwar period to be one of progress in electric machinery, and this progress will keep step with progress in other technical fields.

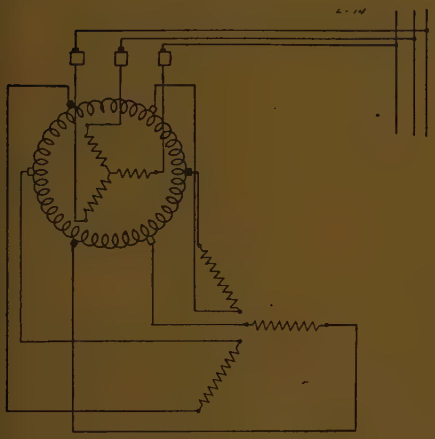
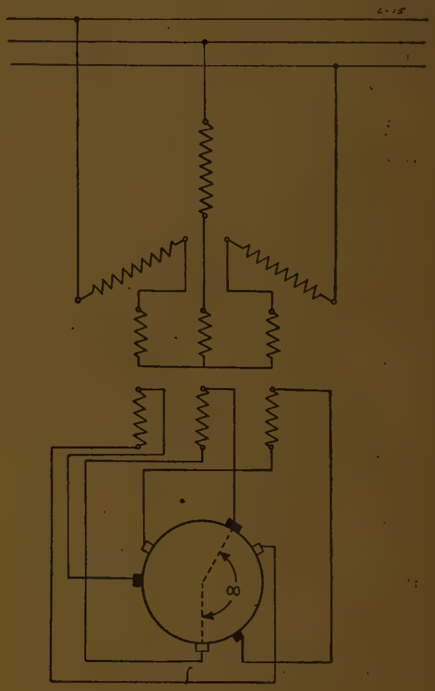


Figure 14. Schematic diagram of a stator-fed three-phase shunt motor

At this point it should be noted that not all the problems in electric machinery have been touched upon, and that there are many more problems which could be discussed. Some new types of electric machines, as, for example, the electric coupling and the Amplidyne, have not been even mentioned. There is one more problem that should be pointed out, however. This is the method of teaching electric machinery.

The progress in electric machinery, as in other fields, has been made through deeper penetration into the matter, and further progress will be made through still more thorough study of the phenomena that occur in the machine. This means that the teachers will have to enlarge their programs. A lengthening of the study time is not desirable. Still less so is an overloading of the mind of the student by more matter. Therefore, other methods of teaching will have to be found—methods based on logic, not on memory.

Figure 15. Schematic diagram of a rotor-fed three-phase shunt motor



When one talks to an engineer who is more or less familiar with the field of electric machines, and who mentions the different kinds of machines as, for example, the synchronous machine or the d-c machine, one gets the impression that he uses different thought processes for each kind of machine. He considers the machines as entirely different.

For the simplest example, consider the electromotive force induced in the windings of the synchronous and of the d-c machine. When the engineer who works in a-c machines is asked about the electromotive force of the a-c machine, he writes the formula:

$E=4.44fNK_dK_p\Phi10^{-8}$ volts

But, if he were asked about the electromotive force induced in a d-c machine, he probably would try to apply an entirely different method of attack or would refer to a textbook. This would not be necessary if he

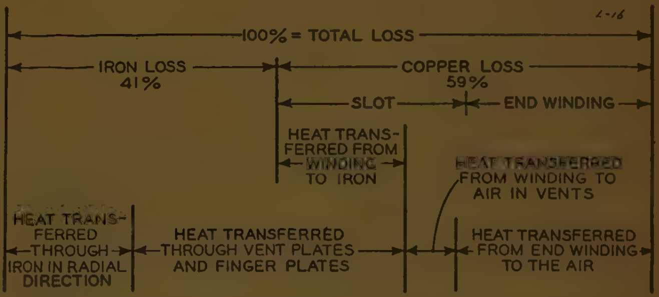

L-16
100% = TOTAL LOSS
IRON LOSS 41%
COPPER LOSS 59%
SLOT
END WINDING
HEAT TRANSFERRED FROM WINDING TO IRON
HEAT TRANSFERRED FROM WINDING TO AIR IN VENTS
HEAT TRANSFERRED THROUGH IRON IN RADIAL DIRECTION
HEAT TRANSFERRED THROUGH VENT PLATES AND FINGER PLATES
HEAT TRANSFERRED FROM END WINDING TO THE AIR

Figure 16. Heat-loss diagram for 1,600-kva synchronous generator

knew that the d-c machine is also an a-c machine, except that it has a special device, the commutator. He could then use the same formula as for the a-c machine. A correct knowledge of the function of the commutator would tell him that the brushes pick up the amplitude of the a-c electromotive force, so he would multiply the a-c formula that gives the effective value by $\sqrt{2}$. The distribution factor of a d-c winding is $2/\pi$, or the diameter divided by half the length of the circle.

When one asks a young engineer why the synchronous machine runs synchronously, one does not often get a suitable answer. The student never thinks about this, because the synchronous machine is usually treated apart from other types of machines.

There is no justification for treating the synchronous machine, the induction motor, the d-c machine, and so on, as different machines. There are three fundamental laws that govern all electric machines, and these laws suffice for the investigation of even the more complicated problems, as, for example, the skin-effect problem in conductors.

The teaching of electric machinery should start with the fundamental laws, explaining them in a general manner so that they can be applied to all kinds of electric machines. This includes information about the windings, and a complete treatment of the magnetic circuit and of the leakage reactances for all electric machines.

Teaching the operation of the electric machines should follow. The shortest way to teach the operation of the electric machines is to start with the transformer, since the transformer is the simplest a-c apparatus. The induction motor must follow, because the induction motor is a general transformer. It transforms not only the voltage, but also, the frequency. It is scarcely necessary to mention that we use, according to the AIEE standards, the equivalent circuit of the transformer in order to determine the performance of the induction motor.

After an explanation of the fundamentals of speed control of the induction motor by the use of an impressed voltage on its slip-rings, the synchronous machine appears as a special case of the induction motor, namely, the case where the impressed voltage is a d-c voltage. The use of the transformer diagram for the synchronous machine is then justified. The two-reaction theory that is used in synchronous machines is not a new principle that changes the character of the synchronous machine as a transformer. It is only a refinement necessary for the salient-pole machine.

The d-c machine should follow the synchronous machine. Yet, the d-c machine can be treated before, or parallel with, the synchronous machine when it is emphasized that the d-c machine is actually an a-c machine. The commutation problem is an a-c and not a d-c problem. The rotary converter then associates the synchronous machine with the d-c machine. The losses and heating must be treated from a general point of view, since the methods of their calculation are the same for all machines.

I believe that this method of teaching electric machinery is the shortest and most logical. It gives the student a far better understanding of the phenomena in electric machines, than does the practice of treating each machine as an individual unit.

"Klydonogram" Reproduced on Golf Green by Lightning Stroke

Lightning striking the smooth wet surface of a golf green at the South Hills Country Club, Pittsburgh, Pa., burned this unusual lacey pattern into the grass. The figure was similar to that produced by positive discharges on sensitized photographic films used in the Klydonograph, an instrument for the investigation of surge phenomena. The 16 main branches of the figure varied in length radially between 61 and 70 inches. The lightning left a hole 1½ inches in diameter and 1¼ deep at the center. P. H. McAuley (A '36) and Edward Beck (M '35) engineers of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. are shown examining the terrain after the storm

A Letter on the Kilgore Bill

From Vannevar Bush (F'24) to Senator H. M. Kilgore

My dear Senator Kilgore:

As I promised in my letter of August 18, I am now writing you a further letter in regard to S 702. It is a ong letter, for I have commented not only on the bill tself, but also more broadly on the general subject, in he attempt to give you my thoughts in a constructive manner. These comments apply not only to S 702 but also to its companion bill, HR 2100, which was introduced by Mr. Patman on March 5, 1943, and was referred to the House of Representatives' committee on patents.

This problem that we both have been studying is exceedingly important. Since it may well involve the future health, comfort, and safety of this nation to an extraordinary degree, its importance warrants all of the effort which you and your committee have been devoting to it.

It has two phases. One is the appropriate organization of science and technology for the prosecution of the war. The second is the corresponding problem in times of peace.

WARTIME IMPLICATIONS

In my opinion, these two phases cannot be treated as a unit. In times of war this great democracy does many things that are aimed at a relatively brief intense effort. We centralize authority, subject ourselves to rationing and restraints, and send our sons to fight under the necessary rigors of military organization. Events have already shown that a democracy which thus girds itself for war can contend successfully with the most rigid of totalitarian states. In fact, it can overcome them, for the resourcefulness initiative, and self-reliance which are engendered in a people by the privileges of democracy, when marshalled under a temporary authoritative war organization, can surpass by far the performance of any permanently regimented people in the complexities and technicalities of modern war. We have already proved this in Africa, in the Far East, and over Europe, and we will prove it again and again as the war progresses. I trust that we as a people will never forget what we have learned and are learning during this war period.

Thus, in time of war, I believe in a centralized control, and I believe such control can appropriately be applied to science and its applications, if every effort is made in the process to preserve the independence of action of scientific and technical groups within their assigned spheres of action to the maximum possible extent. This has been the philosophy of the Office of Scientific Research and Development, and the record will show that it has been successful in its fields of development of new weapons and military medicine.

As applied to the war period, S 702 seems to have four major objectives. First of all, it would alter the existing administrative organization of scientific activities by setting up an Office of Scientific and Technical Mobilization having the powers specified in section 4 of the bill. Secondly, it would further amend the provisions of the Selective Training and Service Act of 1940, as amended, by setting up a separate procedure for the granting of occupational deferments to people having scientific or technical training and experience. Thirdly, the administrator of the Office of Scientific and Technical Mobilization would be given certain powers with respect to the requisitioning of scientific and technical facilities during the war. Lastly, the bill would vest in the Office of Scientific and Technical Mobilization very broad and far-reaching patent rights. I think that it may be helpful for you to have my comments on and reactions to each of those wartime objectives.

Administration of Wartime Scientific Activities. As I pointed out in some detail in my letter to you (dated December 7, 1942), commenting on the bill (S 2721) that you introduced at the last Congressional session, there is an adequate existing administrative setup handling the necessary scientific war activities. Under Executive Order 8807, the President granted rather broad powers to OSRD, a temporary war agency, concerning the planning, co-ordination, initiation, and support of scientific and medical national-defense research activities. These powers have been carefully scrutinized for the past several years by the Congressional appropriation committees, and the congress has seen fit to finance OSRD's operations by providing the necessary appropriations. Acting under that authority provided by the President and the Congress, OSRD has become the keystone of a closely integrated, highly co-operative organization of war research and development work for the Armed Services. That such an organization has been and is successful is best evidenced by the great confidence shown in it by the Armed Services and by the extremely important results that have been achieved.

It seems to me that it would be ill-advised and dangerous to throw a "monkey wrench" into such finely meshed machinery at this late date by such a major administrative

As director of the Office of Scientific Research and Development, Doctor Bush is eminently qualified to analyze the wartime implications of the Kilgore Bill S 702 and its companion Patman Bill HR 2100. He is equally well qualified to analyze their peacetime implications by virtue of his achievements and standing as a scientist, engineer, educator, and administrator, for which he recently was awarded the AIEE 1943 Edison Medal.

The AIEE board of directors adopted resolutions opposing passage of these bills on June 24, 1943. This action was reported and the provisions of the bills were outlined in the August 1943 issue of "Electrical Engineering" (pages 360–1) which also carried additional comments in the "Letters to the Editor" columns (page 381). Further correspondence on this important topic is invited.

Vannevar Bush is president, Carnegie Institution of Washington, Washington, D. C., and director, Office of Scientific Research and Development, Washington, D. C.

change as is reflected in S 702. Because of the inevitable disruption and confusion that would result from such a major organizational change, it seems to me that the Congress might better concentrate its efforts on remedying any flaws that you may find in our existing organization rather than attempt to superimpose an over-all organization at this late date in the war period.

Wartime Utilization of Scientific Personnel. The second major wartime change reflected in S 702 concerns the better utilization of our scientific personnel by amending the Selective Service Act. Subject to that act and all the powers and regulations of the War Manpower Commission, OSRD has mobilized a large percentage of the best qualified scientists and technicians of the country, primarily by means of the execution of contracts with educational institutions and industrial organizations whereunder specific war projects are conducted. However, OSRD's powers concerning the utilization of scientific personnel in war work have not included any authority to affect in any way the operations of the Selective Service System by controlling generally the disposition and utilization of men having scientific and technical training. The relationship of our scientific man power to the Selective Service procedure has not, in my opinion, been clearly defined, and the procedure for ensuring that men of this special training are used to full advantage in places where their talents could best further the war effort has been ineffective. It seems to me that the prosecution of modern war requires the treatment of scientific men as a special group to be specially allocated for work in the fighting services and in civilian research, and that this cannot be done adequately under the present procedures of the Selective Service System. There is no question here of shielding a special class against the rigors of war. It is rather the question of the intelligent use of a great nation's asset. The young men who make up this group should be under orders to serve where needed and, if the public interest indicates that they should remain in the laboratory rather than serve in the field, they should be retained in the laboratory. Likewise, when they are needed in the field they should be transferred there under orders to share the combat hazards with the members of the Armed Services in performing their duties. In other words, the scientific group should have their own selective service system, adapted to placing them exactly where needed.

My comments on this point are not intended to be in criticism of the efforts of the present Selective Service System because my point is directed rather to the legislative basis on which they operate. As a matter of fact, in spite of its inherent difficulty, much progress has been made on the job by the co-operation between the various governmental agencies involved. The problem is far from solved, however, and even at this late date I think that it would be advisable to enact legislation placing the matter on a firm basis. Therefore, I suggest that the Congress might well consider section 5 of S 702 along with other pending legislation affecting the operations of the Selective Service System in order to work out as soon as possible a solution to this problem that is consistent with the solution to other manpower problems.

Requisitioning of Scientific Facilities for War. Concerning that part of S 702 dealing with the requisitioning of scientific and technical facilities needed by the Government for war purposes, it seems to me that no such legislation is needed because the present patent and war-emergency laws are adequate for the purpose. Under existing legislation, the Government has the right to requisition facilities and to use patents needed for war purposes in cases where it is not possible to negotiate with the owners. Although such power is now available for use, it has been the experience of OSRD that it is necessary to exercise such powers only in the most exceptional cases. As a whole, we have found the owners of facilities and patent rights to be more than willing to turn over the use of their property to the Government for war work on a reasonable basis.

Wartime Use of Patents. The last point covered by S 702 in wartime concerns the vesting in the Government of certain patent rights. On this point, I think that it is important for you and your committee to consider the possible effects of such legislation on the prosecution of the war. Since the declaration of the national emergency on May 27, 1941, the Government has entered into thousands of contracts calling for work in connection with the development and improvement of war weapons. At least in the case of OSRD, all research and development work has been done under such contracts on a nonprofit basis, both by educational institutions and commercial organizations. In handling inventions made by commercial organizations under its contracts, OSRD has followed the lead of the Army and Navy by providing in the contracts that the Government shall receive a royalty-free license to such inventions for specified purposes and that the title to such inventions shall vest in the contractors. In a great many such cases, of course, the contractors concerned have worked for many years, spent considerable sums of money, and accumulated many patent rights before they arrived at the point of development reached at the time of the execution of their first Government contracts. Thus, work under Government contracts frequently involves only minor adaptations of past inventions made by the contractors, and in such cases the contribution to the final product attributable to the work financed by the Government is relatively insignificant. In all such cases the Government has followed the theory that it should pay reasonable royalties for the use of inventions made prior to the Government contract and should receive only a royalty-free license for developments made under a Government contract.

The theory expressed in section 7 of S 702 constitutes a radical departure from the theory heretofore followed by the Government in dealing with war contractors concerning patent rights. I think that it is important to recognize the fact that such a radical departure undoubtedly will be vigorously fought by those persons and organizations opposed to the theory that the Government should be the owner and custodian of all inventions made since May 27, 1941, under contracts or other arrangements whereby the Government has contributed "any money, credit, physical facilities, or personnel." Even though provision is made for the payment of fair and just compensation for the seizure of such property rights, there will be many who will protest that the Government has broken faith with those who have relied upon equitable contractual agreements entered into in good faith by organizations whose primary purpose has been to make more effective the prosecution of the war. It is my considered judgment that the storm of controversy that would arise upon the enactment of such far-sweeping legislation, especially from those large commercial organizations whose comete co-operation and attention is vitally needed in the ar program, would do irreparable harm to the united nd concerted program for the development, improve-ent, and utilization of war weapons that is now being arried on so effectively. Therefore, I suggest that con-deration of a radical departure from the present govern-iental system of handling patent rights at least be deferred ntil after the war is won and that it then be made the ıbject of very careful study before action is taken.

On the general question of the advisability of such patent egislation, I wish to point out that ıe President has appointed a Patent 'lanning Commission which has een working on this general prob-em for some time. I regard the rst report of the commission (*EE*, *ept. '43, pp. 423–4*) as being a valu-ble step toward effectuating certain dvisable changes in our patent ystem, and I understand that the ommission is now at work on a econd report dealing with the prob-em of Government ownership of atent rights. In view of the com-lexity of the problem, I believe that t is advisable to await the results of he commission's study before any ttempt is made to enact legislation.

1. The proposed administrative changes are undesirable and would be detrimental to the effective prosecution of the war.

2. The proposed requisitioning power covering scientific facilities is not needed.

3. The proposed change in the Selective Service system concerning scientists and technicians should be considered carefully by all the Congressional committees studying the man-power problems.

4. The proposed changes affecting inventions and patent rights should not be made during wartime because they would be a source of confusion and dissatisfaction that would be harmful to the war effort.

My personal views concerning our atent system have been expressed efore the Temporary National Eco-omic Committee, but perhaps it vill be helpful to summarize them here. In my opinion, one of the primary factors bringing about our extraordinary technical advancement and our high standard of living has been the fact that this country has had a sound patent system stemming from the Constitution. That system now needs some revision in order to make it consistent with modern conditions and to benefit from our past experience. Any such revision, however, should be made deliberately and with great care so that the fundamentals which have proved so valuable to the country over a long period of time are not injured. I believe that it is essential to the health of our industrial life for us to have a constant influx of new, small, and aggressive companies, and our sound patent system up to date has made possible the advent of such companies. Thus, it seems to me that basically our present patent system furthers the public interest.

Of course, it is inevitable that over a period of time the Government should accumulate a large number of patent rights, especially considering the present number of Government employees and Government contracts providing for such acquisition. I agree with other commentators that at the present time we have no fully adequate method of handling such patent rights for the full benefit of the public, and I am in complete sympathy with the attempts of the Patent Planning Commission to work out a uniform administration applicable to all Government agencies that will be in the best public interest. However, inasmuch as the patent-system problems cover many issues that are complicated by war conditions and are quite unrelated to the general scope of S 702, I think that the problem requires separate legislative treatment and full consideration by all the Congressional committees having jurisdiction over patent problems.

Summarizing my views on the wartime aspects of S 702, it seems to me that: (1) the proposed administrative changes are undesirable and would be detrimental to the effective prosecution of the war; (2) the proposed requisitioning power covering scientific facilities is not needed; (3) the proposed change in the Selective Service System concerning scientists and technicians should be considered carefully by all the Congressional committees studying the man-power problem; and (4) the proposed changes affecting inventions and patent rights should not be made during wartime because they would be a source of confusion and dissatisfaction that would be harmful to the war effort, but certain such proposals might profitably be referred to the Senate and House committees on patents for consideration along with other suggestions concerning the improvement of our patent system. Thus, I conclude that no overall legislation of the type embodied in S 702 is needed at this time concerning the organization of scientists in connection with the war effort.

PEACETIME IMPLICATIONS

That leads me to approach S 702 from the standpoint of studying its proposals concerning the appropriate peacetime organization by the Government of the scientific affairs of the country. This aspect is fully as important as the first, especially since we are getting along reasonably well in applying science to the war effort, and it is important for the prosperity and safety of the country that equally successful relations between the Federal Government and the scientists be maintained in the years of peace to come.

You and I have in view the same end; namely, the best furtherance of science for the benefit of the country. Although we may differ in our analysis of the methods to be followed in achieving that objective, I think that the matter is of such importance that it should be studied from every angle and every shadow of thought explored in an attempt to reach the best solution. It is in what I think is a spirit of constructive criticism that I find myself in disagreement with details of the peacetime aspects of S 702 and even more strongly with the underlying philosophy upon which they are formulated. I am in agreement with other aspects of the bill, however, and I shall attempt to emphasize these and point out the means which my experience in science and Government leads me to believe will form the basis for beneficial legislation.

Before discussing the effect of the proposed legislation on different scientific groups, it seems advisable to point out that my analysis is based on the assumption that "all agencies and departments of the Federal Government," as used in section 4(*f*) of S 702, means "all agencies (of the Federal Government) and departments of the Federal Government." If a broader meaning is intended under which the power of co-ordination given to the Office of Scientific and Technical Mobilization would extend to nongovernmental agencies as well as agencies of the Federal Government, many of the comments which I shall set forth would be quite different. The question of interpreting properly the quoted words brings up what I think is a fundamental inconsistency between the extremely broad purposes set out in section 1 of S 702 and the much more limited powers that would be given to the Office of Scientific and Technical Mobilization under section 4 in order "To effectuate the purposes of this Act, ..." It seems to me that this inconsistency should be recognized by a narrower definition of the purposes of the act.

There are three great groups of scientific and technical men in this country: those in public service, those in industry, and those in universities and nonprofit independent scientific institutions. In considering the need for central control over science by the Federal Government beyond that which existed prior to the war, it is necessary to examine and analyze these three groups separately.

Scientific Personnel in Government. We should, of course, continue scientific activities on the part of agencies and departments of the Federal Government, and the Congress should support such activities generously because there are many phases of scientific work that can best be done by men in the Government service. As a nation we can be proud of the accomplishments of many of our Government laboratories, such as the Bureau of Standards, the Public Health Service, several of the Department of Agriculture laboratories, and so on. In the past there have been several proposals to centralize all government scientific work in a single department, possibly making this a new Department of Science with cabinet representation. This idea is attractive to many, especially as it would seem to give an added recognition and support to science in Government departments. There are, however, several disadvantages to such a full unification of governmental scientific effort that should be weighed carefully before any such move is effected.

The greatest difficulty would lie in divorcing each separate Government scientific effort from close association with the department most interested in its work. For example, the scientific work of the Bureau of Entomology and Plant Quarantine, the Bureau of Agricultural Chemistry and Engineering, and other such bureaus, is almost inseparably connected with the work of the Department of Agriculture as a whole. Similarly, the Geological Survey derives strength by being a part of the Department of the Interior. Examples of this sort could be multiplied. I am sure that centralized control by a new independent agency of all scientific work in Government departments would be strongly resisted. Certainly the War and Navy Departments would insist that they control absolutely the secret work on new weapons which they conduct in their own laboratories in times of peace, much as they might be willing to supplement their own activities by requesting and receiving help from the universities, industry, and other governmental laboratories. Therefore, I have come to the conclusion that it would be difficult to gather all science activities of the Government into one organization without serious sacrifice. As a matter of fact, I judge that you have reached the same conclusion because I do not find any such complete integration of governmental research in the bill.

In section 4(*f*), however, I do find a provision for the co-ordination of the governmental research activities of the various Federal agencies and departments. This, I judge, is not intended to imply either power to direct or power to control, independent of the heads of departments and agencies, but rather a central scientific clearing house set up for the interchange of data and plans in order to prevent overlapping and to facilitate that cross-fertilization of scientific effort which is often highly valuable. I have long thought that a body set up for this explicit purpose might perform a very useful function. It should certainly have joined with it an advisory scientific group, drawn on a voluntary basis from the best-qualified scientific personnel of the country. There has been an increasing tendency in recent years, much to be welcomed, for individual bureaus to establish such advisory groups for their own purposes. They have often acted as reviewing bodies for the heads of the departments concerned, and their influence has been important and beneficial. A central body would form a desirable linkage between these.

In passing, allow me to present a thought in this connection which is not a part of the bill, but which is allied with this matter. I have often wondered that the Congress and its committees do not avail themselves more freely of the advice of the scientists of the country. True, the Congress has available all of the scientific men in the executive departments for aid when it approaches a problem of scientific nature, but it does not often call upon more widely constituted groups. The departments and agencies often seek advice in this manner, turning usually to the National Academy of Sciences, which was constituted by Congress for this explicit purpose. Some agencies, notably the National Advisory Committee for Aeronautics, include scientific men in their organizations who serve on a voluntary basis, and I think that all will agree that this has worked well in the case of the NACA. But the committees of Congress themselves seldom use the scientists of the country directly, much as these men are willing thus to contribute their services voluntarily to their country's welfare and interests, and I feel that this could be done to advantage.

It may well be asked: How does one select scientists for this and similar purposes, in order to be sure of their ability and disinterestedness? Such a question is pertinent to a discussion of the bill, for I feel that its provisions for the selection of the necessary scientific personnel are not adequate for ensuring the services of men of the necessary caliber.

There is only one sound criterion for estimating the standing and capability of a man of science, and that is the evaluation of the way in which he is regarded by his colleagues in his profession. If there were only one way of doing this, perhaps it might not suffice, but there are many. Membership in scientific societies of standing is important, wherever such membership is dependent upon evaluation and election. Recognition by learned bodies is a guide. There are even lists of outstanding scientists, prepared by taking ballots among scientists themselves. Some of the scientific bodies, notably the National Academy of Sciences, have the recognition of the Congress in their charters. The American Association for the Advancement of Science, through a carefully prepared system

So far as Government scientists are concerned, the bill does not now provide adequately for the correlation of their efforts, and it would be inadvisable to extend the bill to the point where unitary control of all governmental research would be exerted, but there is an opportunity in this field for beneficial correlation of effort.

of representation, integrates the large membership in very many scientific organizations throughout the country. It seems to me that some of this existing machinery should be utilized in the procedure of selecting representative cientists for a governmental purpose in order to select epresentative men having the confidence of scientists generally. It can safely be assumed that men elected for eminence in cience by scientists themselves will also generally be disinterested, for men can very seldom rise to eal prominence in science in the estimation of heir colleagues unless hey place science itself irst in the ordering of heir professional careers.

The general idea of having various units in an industry competing on the basis of which one can supply the public with the best goods at the lowest cost is hard to improve upon in theory, and in general it has worked well in practice. The industrial laboratories are an essential part of this process, and they should be subjected to as little centralized control as possible.

In reviewing the bill, and in thinking of postwar scientific organization generally, I believe this point is important, and it seems o me that the present provisions in the bill for securing he services of scientists in the contemplated organization are not designed to secure the best men possible. Furthermore, these same comments apply to the membership f the so-called National Scientific and Technical Board and the advisory committee.

My summary, then, so far as this first group of Government scientists is concerned, is that the bill does not now provide adequately for the correlation of their efforts and hat it would be inadvisable to extend the bill to the point where unitary control of all governmental research would be exerted, but that there is an opportunity in this field for beneficial correlation of effort.

Industrial Scientific Personnel and Laboratories. The econd group of scientists and technical men to be considered are in the research laboratories of industrial organizations. There are over 2,000 such laboratories, arge and small, and their work is of great importance, particularly in view of the growing tendency in this country mong large industrial laboratories to carry on research f a fundamental scientific nature and to publish the results.

During the war these industrial laboratories have been f great importance in the development of weapons, working under contracts with the Army, the Navy, and the Office of Scientific Research and Development. As far s the latter is concerned I can testify that we have had ffective co-operation from the group at every point, that ey have accomplished results of great importance, and hat with negligible exceptions they have decidedly laced the interests of the country first and have not allowed their commercial interests to interfere with their ontributions to the general cause. I have already discussed the provisions of the bill that would alter in several ays the relationship of these laboratories to government n the prosecution of research on new weapons during he war, and I have noted that I do not feel that new legislation is needed for this purpose.

The position of this group of scientists under the bill uring the postwar period is hence the primary point for onsideration. As I interpret the bill, they would not be reatly affected because most of the clauses which would alter their relationships are limited to the duration of a state of war. Presumably, the funds of the new Office would be used, in times of peace, either to construct and operate new governmental laboratories or to utilize the facilities of existing laboratories under contract. While some industrial units might elect to operate their laboratories in that way, the chances are that in time of peace most industrial units would not wish to perform any substantial amount of their scientific work under government contract, especially considering some of the provisions in S 702 concerning patent rights. Furthermore, I doubt if these industrial laboratories would accept in peacetime contracts consistent with the OSRD nonprofit theory as applied to research and development contracts. The alternative of including a large profit under the contracts, in the attempt to enlist the voluntary participation of these laboratories in a peacetime plan, is certainly not an attractive procedure.

As a matter of general policy, I do not believe that it would be wise for Government to attempt to control the operations of these industrial laboratories, as might possibly be implied in the purpose specified in section 1(4), although presumably not within the scope of the powers and duties that would be given the new Office. The industrial laboratories form an integral part of the industries with which they are associated, and form a part of the mechanism by which units in a single industry, and entire industries, compete with one another. Moreover, their particular part in such competition is directed explicitly toward the provision of better products for public consumption. The maintenance of such an atmosphere of competition, as opposed to close government regulation of monopolistic combinations engaged in manufacturing the products which the public needs, has been the philosophy behind a large amount of legislation during the past generation, and I believe that such a philosophy is in the public interest. Undoubtedly our laws regarding trade combinations can be improved, or at least clarified, in order to render the system more fully beneficial; but the general idea of having various units in an industry competing on the basis of which one can supply the public with the best goods at the lowest cost is hard to improve upon in theory, and in general it has worked well in practice wherever it has been truly operative. The industrial laboratories are an essential part of this process, and I feel that they should be subjected to as little centralized control as possible.

Federal subsidy of the independent science of universities and other institutions may be beneficial, and it may be necessary in the years to come if we are to preserve that preeminence in science as a nation which is essential to our progress. However, the support should be divorced from governmental control of the scientists and laboratories themselves, or it will stifle rather than expedite their true accomplishments.

Scientific Personnel in Universities and Institutions. That brings us to a consideration of the proposed postwar effects of the bill on the third class of scientists, namely, those in universities and nonprofit independent scientific institutions, and it seems to me that this group may be primarily affected.

In time of war it seems to me that the public interest demands that this group should be closely organized in order to apply its accumulated scientific knowledge to the direct needs of the Armed Services for developing new weapons and equipment and for meeting the needs of military medicine, and this organization has been accomplished by the Office of Scientific Research and Development, a war agency. Although such organization is necessary in time of war, it seems to me that in time of peace the scientists in this group should be given a maximum of freedom and a minimum of control from any source. Therefore, I think that it would be a mistake to attempt to control their activities through a federal agency.

Since science flourishes to the greatest degree when it is most free, we should bend our peacetime efforts not to perpetuate any of the necessary wartime controls we have created for our defense, but rather to return the maximum of independence to our scientific institutions and our scientific men.

Of course, in view of the fact that many private institutions may be unable to finance an appreciable amount of scientific research activity after the war, it may be advisable or even necessary for such institutions to look to the federal and state governments for financial support. Our past experience in this country has shown us that it is possible for such governmental financial support to be given without being attended by stifling control, but the factual situation may be different after this war. For example, it seems to me that the high scientific standards of which quite a few state-financed institutions can be proud are attributable in no small part to the fact that up to the present time such institutions have been competing against privately endowed institutions with exceptionally high standards which were in a position to attract very outstanding scientists who felt that their efforts in state institutions were too closely controlled. If such competition is still present after the war, I can foresee many advantages and few disadvantages of Federal financial support of the research activities of scientists in universities; if, however, there is no such strong competition, we must be careful lest federal financial support carries with it features of undesirable control.

Thus, I think that federal subsidy of the independent science of universities and other institutions in this country may be beneficial, and it may in fact be necessary in the years to come if we are to preserve that pre-eminence in science as a nation which is essential to our progress. But, unless we have the wisdom to extend support wisely, it may do much more harm than good. If federal support is to be given, strenuous efforts will be necessary to ensure that it furthers the work of the best and most brilliant scientific minds, and does not merely increase the bulk of mediocre work. And the support should be divorced from governmental control of the scientists and laboratories themselves, or it will stifle rather than expedite their true accomplishments.

The presence of a great body of highly able scientific men in this country has recently been an indispensable asset in time of danger. We must be sure that it is again present if we are again threatened, and science of the highest type flourishes best when it seeks its own objectives and pursues its own uninhibited ways. If we perpetuate in this country in the years to come a scientific atmosphere and body of men of the caliber that we now have, I will fear no threat from any source, for in time of need they will again respond, they will again direct their full energies in a patriotic effort, working under a closely unified and controlled program of the application of science in the prosecution of war, and they will thus do their full part in the protection of this country.

In conclusion, I wish to point out that there is another aspect of this whole subject of the furtherance of science. It extends beyond the mere application of the fruits of science to improve the comfort of the people, and it is on a more fundamental basis even than the safety of the country to external danger. The broad object of science is to increase the knowledge and the understanding of man. It aims at extending his grasp of the environment in which he lives, and his appreciation of the vast and intricate system of nature by which he is surrounded, from the study of the remote stars to the constitution of the smallest atom. We need science for this as well, so that as we live we may derive satisfaction by growing in knowledge.

Since after many years I have come to the realization that science flourishes to the greatest degree when it is most free, I feel strongly that, when peace comes, we should bend our efforts, not to perpetuate any of the necessary wartime controls which we have created for our defense, but rather to return the maximum of independence to our scientific institutions and our scientific men, wherever they may be located.

Very sincerely yours,

V. Bush

Societies Oppose Kilgore Bill

Since the board of direction of the American Society of Civil Engineers studied bill S 2721 at the request of Senator Kilgore and expressed unanimous disapproval of its provisions on February 19, 1943, many other scientific and engineering societies as well as AIEE have crystallized their opinions in resolutions addressed to Senator Kilgore. The organizations which have made formal representation thus far have revealed unanimous dissent with the proposed measures of the original bill, the revised bill S 702, and its companion bill HR 2100. ASCE expressed additional adverse criticism of S 702 in April 1943. AIEE adopted its resolution opposing the bills in June; the war policy committee of the American Institute of Physics publicized its opposition in July; the Institute of Radio Engineers and the American Association for the Advancement of Science voiced their objections in August; and the council of the American Society of Mechanical Engineers joined the opposition in November. The Society of Automotive Engineers has referred the matter to its local sections for discussion and individual action.

Mathematical Training for Young Engineers

C. A. POWEL
FELLOW AIEE

A QUESTION frequently raised is how much mathematics does industry expect of the students graduating from our colleges. The answer depends largely on the capability of the individual student and how the particular enterprise he has joined intends to use him.

Basically, mathematics should not be taught to engineers as an end in itself. Engineers are essentially practical people trying to produce something very tangible. If they have to use mathematics at all, it is purely as a tool. Educational courses should be set up with this in mind and with the realization that the student's ability to visualize the mathematical processes in the light of their physical counterpart is the thing that will make him useful to industry later on. This is not a new idea, and some excellent textbooks have been written with just this in mind. For instance, Doherty and Keller's book, "Mathematics of Modern Engineering," is typical and adequately fulfills this purpose.

Mathematics should be taught to the young engineer, not as an end in itself, but as a tool to be used to gain his objectives. The ability of the young engineer to use mathematics successfully in his work rather than the extent of his actual knowledge in this field is a gauge of his usefulness to industry.

At Westinghouse Electric and Manufacturing Company we receive from the colleges every year a large number of engineering students. Most of them go into design and production work that does not require advanced mathematics. For this reason there does not seem to be much justification for burdening undergraduate courses with much mathematics as a requirement. Most of the young engineers we take on have adequate mathematical preparation.

On entering industry, the young engineer will find that the work expected of him can be separated into three levels:

> The first or basic level involves the utilization of information already accumulated and being used currently by his coworkers. It covers the use of standard data, formulas, and engineering memoranda, all well-tried and carefully checked, and requires a moderate amount of training and ease in handling figures and equations with accuracy.
>
> The second or intermediate level of engineering activity involves the study of current scientific literature in order to extract new methods of analysis and technique. The articles in general will be written by specialized engineers, physicists, and mathematicians, and will require serious application and good general training. Success in this direction requires mathematical manipulation of a somewhat higher order.
>
> The third and highest level of engineering involves the original solution of problems encountered by the individual himself. This means charting new courses and requires a fundamental knowledge of mathematical analysis of a much higher degree than the first two levels.

Industry expects the young engineer to be trained to the point where he can absorb existing information and keep abreast of current progress in his chosen field. This requires that in his undergraduate years he should have mastered geometry, college algebra, trigonometry, differential calculus, and integral calculus. There should also be an elective in differential equations for those students who are mathematically inclined. Any continuation beyond undergraduate work requires differential equations. In the Westinghouse graduate program offered in co-operation with the universities of Pittsburgh, New York, Stevens Institute, and so forth, we require a full year's work in differential equations as a prerequisite for such advanced courses as engineering mathematics, basic concepts of physics, and so on.

To enter the third level involving original work, more training than is provided in an undergraduate course is required. This may be obtained as postgraduate work in the university leading to a master's degree or a doctor's degree, or it may be obtained through personal effort in industry itself.

Students who are candidates for the master's degree usually are possessed of greater analytical ability and have greater natural aptitude for investigational work. They are, therefore, better qualified to pursue training in higher mathematics. Such students should be required to take, besides the year's course in differential equations, an additional course selected from such subjects as functions of a complex variable, vector analysis, Fourier integrals, and Heaviside's operational calculus.

For the doctor's degree the student should have, in addition to the requirements for the master's degree, at least two of the previously mentioned mathematical subjects, and also a rigorous course in the mathematical theory of electricity using Maxwell's equations as a basis. A course of this type is covered in Becker's translation of Abraham's book, entitled "Electricity and Magnetism," which is particularly good, because it emphasizes the physical significance of the mathematical relations.

Many large industrial establishments in conjunction with nearby colleges and universities offer opportunity for advanced study such as the Westinghouse graduate courses after the student has entered industry. In this respect, there is room for improved co-operation between the colleges in the matter of recognizing one another's credits, and particularly in waiving the requirement of one year's residence before the granting of a degree. We find that frequently a student is not able

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to obtain an advanced degree because, when he is transferred to a new location, his credits previously obtained elsewhere are not honored.

The exact nature of the advanced study will depend a good deal on the type of work in which the student is interested. These observations apply principally to electrical engineers, who form the greater part of the engineering organization in the Westinghouse company. But some familiarity with the mathematics used in related fields is a decided asset. For example, a power engineer working on circuit theory may find much helpful information in the work already carried out in the communication field. Likewise, we frequently run across cases of mechanical equivalents being used to solve electrical problems, and vice versa.

We have found a pronounced need for a tie between physics and mathematics. A student may know the physical laws involved in some phenomenon and he may be able to solve differential equations, but the difficulty lies in setting up the equation correctly, which is perhaps the most important step in the whole solution.

However far the student proposes to go in college—bachelor, master, or doctor—the point to remember is that his plan is to become an engineer, and a major part of his time cannot be devoted to mathematics. If he can be made to understand mathematics as a tool and be taught to develop it further in after life as he finds its use necessary to attain his main objective, he will have received everything from mathematics that industry can expect of the colleges.

Magnesium From Sea Water

The increased importance of the production of magnesium metal has become apparent since the war. For one thing, wartime contingencies have given a great acceleration to the use of the lighter metals. Besides its importance as a metal for construction where lightness is paramount, as in the fabrication of both airplane and engine parts, magnesium is the major constituent of incendiary bombs and flares used to illuminate war operations and aerial photography.

Magnesium is the sixth most plentiful element in the earth's crust, and the fourth most plentiful metal. It is never found free in nature as a metal but always combines with oxygen or chlorine, or as a carbonate, sulphate, or silicate. The largest concentrations of the mineral exist in brucite and magnesite, found in limited quantities in the United States, and in the almost unlimited quantities of dolomite, serpentine, and olivine found in this country. It is from these minerals that the metallic magnesium produced industrially has been reduced.

Sea water is the greatest reservoir of the raw material, which is contained therein as magnesium chloride or magnesium sulphate. But the concentration of magnesium is small—about 0.13 per cent—and it would require about 200,000 gallons of sea water to produce a ton of magnesium if all the magnesium could be recovered. Although it is free, and although it has been used as a source for magnesium salts and magnesium metal for several years in the laboratory, production of metallic magnesium from other sources heretofore has been able to compete with that from sea water because of other factors, including materials, plant locations, and power costs.

Recently, however, The Dow Chemical Company, Midland, Mich., began operating a large plant in Texas using sea water for this purpose, the first of its kind in the United States. The process used is a modification of the one originally developed by Herbert H. Dow, founder of the Dow Company, and the man generally credited with the development of the magnesium industry in the United States.

In this process, the sea water is first treated with lime produced by calcining oyster shells and hydrating the lime so produced. This sea-water treatment results in the precipitation of magnesium hydrate, which is allowed to settle in large Dorr thickeners and then further dewatered by filtration. The magnesium-hydrate cake from the filters is then brought into reaction with hydrochloric acid, and the magnesium chloride thus formed is concentrated, purified, and dried. In this state it is used as a feed for the magnesium-producing cells. In the magnesium cells electrolysis of the magnesium chloride results in the formation of magnesium metal and a mixture of air, chlorine, and hydrochloric acid in low concentrations. The acid and chlorine, in turn, are used in the production of hydrochloric acid, which is then used to neutralize additional magnesium hydroxide.

In addition to the plants which the Dow company is building and already has in operation, two other manufacturers in the United States are utilizing the Dow electrolytic cells for production of magnesium metal. These are the Diamond Alkali Company, operating in Ohio, and the International Minerals and Chemical Corporation in Texas. In each of these plants the magnesium-chloride feed for the cells is made by a different process. At the plant being operated by International, a part of the magnesium chloride is produced as a by-product from the manufacture of potassium sulphate, utilizing langbeinite and muriate of potash, both of which are produced at the company's mines near Carlsbad, N. Mex. Basic Magnesium, Incorporated, has installed a plant in Nevada, which utilizes the electrolysis of anhydrous magnesium chloride.

Abstracted from "Magnesium," by Paul D. V. Manning, *Mining and Metallurgy*, August 1943.

evisions Made to “Simplified Calculation of Fault Currents”

A report on a simplified procedure for the
culation of short-circuit currents, pub-
ed as “Simplified Calculation of Fault
rrents” (*EE, Oct. ’42, pp. 509–11; and*
EE Trans., ’42, pp. 1133–35), was sponsored
l prepared by the AIEE committee on
tective devices as one of its projects for
0–42. The method described had been
en trial use for over a year and was found
be generally satisfactory for the purpose
ended.

A recent review of the procedure, however,
ealed the need for certain modifications
order to improve and bring the report up
date. The suggested revisions, pertaining
ticularly to fuses and to fault-current cal-
ations for generating-station breakers,
ve been made and approved by the com-
ttee on protective devices. They are
bodied in the following report, presented
h an amplification of the reasons therefor
J. B. MacNeill, chairman of the com-
ttee.

ALCULATIONS FOR CIRCUIT BREAKERS

In the original paper for breaker applica-
n at generator voltage, a permissive addi-
nal factor up to 20 per cent was recom-
ended for such applications. Subsequent
estigations of the characteristics of various
tems pointed the way to replace this
riable factor by definite ones. It has been
ınd that for systems where the three-phase-
ılt kilovolt-ampere at the generator bus
ltage does not exceed 500,000 (before the
plication of multiplying factors), no addi-
nal multiplying factor is required. For
lculations exceeding 500,000 kva a definite
lditional factor of 10 per cent must be
lded to the several classes of breakers, all
set forth in the revised section A-2 of
able I.

CALCULATIONS FOR FUSES

Under section D-2 of the original table a
ctor of 1.2 was recommended for fuses of
kilovolts or lower, with interrupting rat-
gs not exceeding 3,000 amperes.

This limitation was arbitrary and based
the limits of design at the time the paper
as prepared. Improvement in design of
w-voltage fuses has made this limitation a
rdship on both the users and manufacturers
such fuses. After careful consideration,
was thought that a more logical basis would
the introduction of a X/R ratio in the cal-
ılation, using the entire X value from source
power to the fuse location, but the R value
ly from the fuse back to the first primary
bstation. The error in neglecting the
mainder of R is negligible, and the difficulty
obtaining rigorous values was not com-
ensurate with increase in accuracy ob-
ined. If the X/R ratio is *less than 4*, the
wer multiplying factor of 1.2 is permis-
ble; otherwise the factor of 1.6 should be
ed. Although it was recognized that the same line of reasoning could be applied to higher-voltage fuses which are not current limiting, a survey of many cases indicated that the majority of these cases would fall in the 1.6 class and, therefore, no change is recommended for general use.

Specific mention has been given to current-limiting fuses. *For all voltages the mutliplying factor will be 1.6.* This is so because the basis of such fuse ratings is given on an unsymmetrical current value equal to 1.6 times the symmetrical current. Since the symmetrical value gives the most severe duty to the fuse, it is obvious that the 1.6 factor must be used for all current-limiting fuses.

With the aforementioned points in view, the following directions for changes are given.

At the beginning of the fourth paragraph under the subheading, “Procedure,” change the wording to read thus:

> Fuses are rated on total current, and, as the time durations involved are very short, their required interrupting capacity should be based on the total rms current at one-half cycle, using subtransient reactances for both synchronous and induction machines. Two cases should be considered:
>
> 1. At 15,000 volts or below, except for current-limiting fuses, when the fuse located is remote from generating stations or primary substations (that is, X/R is less than 4) multiply by 1.2. In determining the X/R ratio, it will be sufficiently accurate to use the resistance between the generating or primary substation bus and the fuse location only. The reactance all the way back to the source should be included, however.
>
> 2. In all other cases, including current-limiting fuses, regardless of voltage, multiply by 1.6.

NATIONAL • • • •

Official Nominees Announced for 1944–45

C. A. Powel, manager, headquarters engineering departments, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., was nominated for the AIEE presidency for the year 1944–45 by the national nominating committee at its meeting in New York, N. Y., January 25, 1944. Others named on the official ticket of candidates for the Institute offices that will become vacant August 1, 1944, are:

For Vice-Presidents

R. T. Henry, assistant chief electrical engineer, Buffalo, Niagara, and Eastern Power Corporation, Buffalo, N. Y. (North Eastern District, number 1).

J. F. Fairman, assistant vice-president, Consolidated Edison Company of New York, Inc., New York, N. Y. (New York City District, number 3).

M. S. Coover, professor and head of department of electrical engineering, Iowa State College, Ames, Iowa (Great Lakes District, number 5).

R. W. Warner, professor and head of department of electrical engineering, University of Texas, Austin, Tex. (South West District, number 7).

C. B. Carpenter, assistant chief engineer, Pacific Telephone and Telegraph Company, Portland, Oreg. (North West District, number 9).

For Directors

P. L. Alger, staff assistant to vice-president in charge of engineering, General Electric Company, Schenectady, N. Y.

M. J. McHenry, director of sales promotion, Hydro-Electric Power Commission of Ontario, Toronto.

D. A. Quarles, director of transmission development, Bell Telephone Laboratories, Inc., New York, N. Y.

For National Treasurer

W. I. Slichter, professor emeritus of electrical engineering, Columbia University, New York, N. Y.

In Table I under section *A* subheading, change to read as follows:

	Multiplying Factor	Reactance Quantity for Use in X_1		
		Synchronous Generator	Synchronous Motor	Induction Machine
2. Special case for breakers at generator voltage only For short-circuit calculations of more than 500,000 kva (before the application of any multiplying factor) fed predominantly direct from generators, or through current-limiting reactors only.				
Eight-cycle or slower (♯) breakers	1.1	Subtransient*	Transient	Neglect
Five-cycle breakers	1.2			
Three-cycle breakers	1.3			
Two-cycle breakers	1.[illegible]			

In Table I under section *D* subheading, change to read as follows:

	Multiplying Factor	Reactance Quantity for Use in X_1		
		Synchronous Generator	Synchronous Motor	Induction Machine
D. Fuses				
1. At 15,000 volts, or below, except for current-limiting fuses when the fuse is located remote from generating stations or primary substations (that is, X/R is less than 4)	1.2	Subtransient	Subtransient	Subtransient
2. All other cases, including all current-limiting fuses regardless of voltage	1.6			

♯ * Refer to footnotes with original table.

Future AIEE Meetings

North Eastern District Meeting
Boston, Mass., April 19–20, 1944

Summer Technical Meeting
St. Louis, Mo., June 26–30, 1944

Pacific Coast Technical Meeting
Los Angeles, Calif., Aug. 29–Sept. 1, 1944

The nominating committee, in accordance with the constitution and bylaws, consists of 15 members, one selected by the executive committee of each of the ten geographical Districts, and five selected by the board of directors from its own membership.

The following members of the committee were present at the meeting:

Orin A. Demuth, Portland, Oreg.; A. H. Frampton, Toronto, Ont.; R. C. Gorham, Pittsburgh, Pa.; J. Elmer Housley, Alcoa, Tenn.; Arthur L. Jones, Denver, Colo.; C. H. Kraft, St. Louis, Mo.; C. M. Laffoon, East Pittsburgh, Pa.: Everett S. Lee, Schenectady, N. Y.; K. B. McEachron, Pittsfield, Mass.; J. A. Northcott, Jr., Notre Dame, Ind.; C. S. Purnell, New York, N. Y.; B. L. Robertson, Berkeley, Calif.; E. W. Schilling, Bozeman, Mont.; W. R. Smith, Newark, N. J., and H. H. Henline, secretary, New York, N. Y.

The constitution and bylaws of the Institute require publication in *Electrical Engineering* of the nominations made by the national nominating committee. Provision is made for independent nominations as indicated in the following excerpts from the constitution and bylaws:

Constitution

Section 31. Independent nominations may be made by a petition of twenty-five (25) or more members sent to the national secretary when and as provided in the bylaws; such petitions for the nomination of vice-presidents shall be signed only by members within the District covered.

Bylaws

Section 23. Petitions proposing the names of candidates as independent nominations for the various offices to be filled at the ensuing election, in accordance with article VI, section 31 (Constitution), must be received by the secretary of the National Nominating Committee not later than March 25 of each year, to be placed before that committee for the inclusion in the ballot of such candidates as are eligible.

On the ballot prepared by the national nominating committee in accordance with article VI of the Constitution and sent by the national secretary to all qualified voters during the first week in April of each year, the names of the candidates shall be grouped alphabetically under the name of the office for which each is a candidate.

BIOGRAPHICAL SKETCHES OF NOMINEES

To enable those Institute members not personally acquainted with the nominees to learn something about their engineering careers and their qualifications for the Institute offices to which they have been nominated, brief biographical sketches are scheduled for inclusion in the "Personal" columns of the March issue.

Subcommittee Reviews Scope of AIEE Technical Committees

A joint subcommittee on adequacy of coverage of electrical engineering field by present technical committees has been appointed by the AIEE technical program committee in response to the question referred to it by the board of directors, of whether the present committees offer sufficient coverage to the fields expanding because of wartime developments. If necessary the subcommittee is expected to recommend creation of new technical committees.

F. A. Cowan (M'29) chairman of the technical program committee has assumed the chairmanship of the new subcommittee. Choice of subcommittee members was made with a view to securing representation from those fields which are expanding rapidly and obtaining proper co-ordination with other committees. Members selected are: T. B. Holliday, air transportation; H. A. Affel, radio and ultrahigh frequency; S. B. Ingram, electronics; J. H. Lampe, electric welding; John Grotzinger, industrial power applications; W. N. Zippler, applications to marine work; F. E. Harrell, electrical machinery; D. C. Prince, planning and co-ordination; J. R. North, A. C. Monteith, standards; P. L. Alger, member at large.

Award of Fortescue Fellowship Postponed for 1944–45

Because of conditions imposed by the war, no meeting of the Fortescue Fellowship Committee will be held and no award will be made for the year 1944–45. A motion to this effect was approved by the members of the committee with the understanding that the funds available would be impounded.

The Fellowship was established in 1940 under the sponsorship of the AIEE as a memorial to Charles LeGeyt Fortescue (A'03, F'21) in recognition of his valuable contributions to the electric-power industry. A trust fund of $25,000 has been set up for this purpose by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., with which Doctor Fortescue was associated throughout his professional career. The income is used to provide fellowships of $500 or more to candidates selected annually by the committee.

Only once has the Fellowship been awarded; the appointment was made for 1940–41 to Norman Z. Alcock, Kingston, Ont. Successive annual awards have been postponed, because the war has absorbed the activities of most of the eligible candidates.

SECTION • • • • •

Milwaukee Technical Discussion Groups Enter Fourth Year

The technical discussion groups of the Milwaukee Section have begun their fourth successful season of highly specialized meetings, according to a report from Carl J. Fechheimer, group co-ordinating chairman. Formation of the groups in 1940 grew out of the recognition that there are widely diversified industries in and about Milwaukee and that a forum for the exchange of ideas and experiences beyond the scope of general-subject monthly Section meetings would be of great value to the specialists.

Three technical groups were organized
originally: electrical machinery, power a
plications and control, and electronics. Th
year a fourth group on basic sciences w
merged with the others; each of the origin
three devotes one of its meetings during t
season to basic sciences. Regular month
Section meetings have continued with topi
of a general nature.

The year's activities for all the groups a
correlated by the co-ordinating chairma
and the executive officers of each group, w
meet at the beginning of the season to dete
mine the calendar of meetings, tentati
subjects, and, when possible, the names
the speakers. From four to six meetings a
held for each group during the year, with a
average attendance of 38. The lecturer us
ally is a local engineering specialist who tal
on his chosen subject for about an hour befo
turning the meeting over to informal di
cussion.

PERSONAL • • • •

F. P. Ogden (M'28) vice-president, Mou
tain States Telephone and Telegraph Com
pany, Denver, Colo., has been elected pres
dent. Mr. Ogden, who was born in She
man, Ky., in 1887, was graduated fro
the University of Kansas in 1911 an
was employed as student engineer by th
Missouri and Kansas Telephone Compan
Kansas City, Mo. He served as distri
traffic engineer in Topeka, Kans., befo
entering the employ of the Mountain Stat
company in 1914 as clerk. During 1915 an
1916 he was district traffic chief in Butt
Mont., becoming division traffic superi
tendent in Helena, Mont., in 1917 an
in Salt Lake City, Utah, in 1921. He wa
made general toll supervisor in 1922 an
general traffic manager in 1923. In 1938 h
was appointed vice-president. **R. W. Lin
say** (A'35, M'38) formerly chief engine
succeeds Mr. Ogden as vice-presiden
Mr. Lindsay received the degree of bachel
of science from the University of Colorado i
1915 and entered the employ of the Mounta
States company as draftsman. From 191
to 1922 he was construction engineer. Aft
serving as outside plant engineer's assista
from 1922 to 1926, and engineer of metho
and materials from 1926 to 1928, he wa
made outside plant engineer in 1928. H
became assistant chief engineer in 1933 an
chief engineer in 1934. **H. E. Jones** (A'2
M'41) formerly equipment and buildi
engineer, advances to the position of chi
engineer vacated by Mr. Lindsay. M
Jones was associated with the Mounta
States company first from 1905 to 192
During this period he was engaged in ou
side plant work until 1908 when he beca
wire chief and district plant chief. In 191
he was shifted to central office installati
and in 1914 became plant chief. From 191
to 1923 he was assistant equipment enginee
He served as maintenance engineer for t
New England Telephone and Telegra
Company, Boston, Mass., from 1923
1926, and for the American Telephone a
Telegraph Company, New York, N. Y.,
1926 and 1927. In 1927 he rejoined t
Mountain States company as maintenan
engineer and in 1940 was appointed equi
ment and building engineer.

C. Gardett (A ’07, F ’41) recently retired ef electrical engineer, and general mana- of the Los Angeles (Calif.) Bureau of ver and Light has been appointed consult- engineer for the city’s Department of ter and Power which has absorbed the eau of Power and Light and the Bureau Water Works. Mr. Gardett received the ree of bachelor of science from the Uni- sity of California in 1904 and since 1911 been employed by the City of Los geles. From 1911 to 1917 he served as stant electrical engineer in the Bureau of Angeles Aqueduct and in 1918 was trans- ed to the Bureau of the Department of blic Service where he had charge of the ign and construction of all generation and nsmission facilities. He was chosen head he design and construction division of the eau in 1930. He was given the additional ies of assistant chief electrical engineer general manager in 1938 and appointed ef electrical engineer and general manager 1940. **R. R. Robertson** (M’25) formerly ign and construction engineer for the eau of Power and Light, has been named ef electrical engineer and deputy general nager of the Department of Water and ver. He has been associated with the dis- tinued Bureau since 1912. Previously had been employed by the Isthmian Canal mmission, Panama, from 1907, when he duated from Purdue University, until 2. **C. P. Garman** (A ’23, M ’26) nerly assistant engineer of design, Bureau Power and Light, has been made deputy eral manager of the power system. Mr. rman joined the Bureau’s staff in 1920 as ior electrical engineer.

S. Fields (A ’20, F ’29) formerly manager the electric department, Cincinnati hio) Gas and Electric Company, has been de vice-president. Born in Kentucky 1897, in 1918 as maintenance electrician operator Mr. Fields joined the Union s and Electric Company which was con- dated in 1936 with the Columbia Gas Electric Company as the Cincinnati Gas Electric Company. Remaining with the ion company until 1926 he advanced to positions of chief electrician in 1920, istant engineer in 1922, and assistant elec- al engineer in 1924. After an association h the Columbia Engineering and Manage- nt Corporation, Cincinnati, during 1926 1927 as assistant electrical engineer and ctrical engineer in charge of design, he urned to the Union company in 1929 as nager of the electrical department and ntinued in that position with the Cincin- i Gas and Electric Company. **D. S. Brown** ’21, M ’36) formerly manager of elec- al production has been named vice-presi- nt in charge of that operation. Gradua- g from the University of Cincinnati in 20 with the degree of electrical engineer, . Brown joined the Union Gas and Electric mpany as assistant superintendent of duction. He was made superintendent production in 1923 and finally manager of duction in 1929.

I. Whitefield (A ’19, M ’25) formerly as- ant division manager, Appalachian Elec- Power Company, Roanoke, Va., has n appointed division manager. He has n associated with the company since 1915 as power engineer, superintendent of lighting and power, district manager, and assistant division manager. **J. W. Hancock** (A ’10) formerly division manager retires from his position to assume an advisory position and directorship with the company. Mr. Hancock first joined the company’s predecessors, the Roanoke Electric Light and Power Company and the Roanoke Street Railway Company in 1895, as accountant and cashier. He became superintendent in 1899, and general manager in 1900. From 1913 to 1927 he also was general manager of the Lynchburg (Va.) Traction and Light Company. In 1926 when the Appalachian company was formed he was named division manager. Mr. Hancock served in the Spanish–American War and is a member of several historical societies and of the Sons of the American Revolution.

E. J. Rutan (A ’20, M ’29) formerly senior engineer, Chemical Construction Corporation, New York, N. Y., is partner and vice-president in the recently formed consulting engineering firm of Rutan and Snead, Inc., New York. Mr. Rutan, who holds the degree of mechanical engineer from Cornell University, terminated a 23-year association with the testing department of the Consolidated Edison Company of New York, Inc., in 1942 when he joined the Chemical Corporation. He has served on AIEE committees as well as on committees of the American Society for Testing Materials and the American Standards Association. **E. W. Starr** (A ’28, M ’36) assistant professor of electrical engineering, Cooper Union, New York, is also a member of the new firm. Professor Starr, a graduate of Cornell University, previously taught at that institution and at Worcester Polytechnic Institute. He has also been connected with the American Steel and Wire Company and the General Electric Company, Schenectady, N. Y.

H. H. Plank (A ’41) formerly assistant to the vice-president, United Gas Improvement Company, Philadelphia, Pa., has been appointed assistant to the vice-president and general manager of the Delaware Power and Light Company, the Delaware Coach Company, and its subsidiaries. After graduating from Clarkson College with the degree of bachelor of science in electrical engineering in 1917, Mr. Plank entered an apprenticeship course in public-utility operation with Henry L. Doherty and Company, Toledo, Ohio, and completed the course in 1920 when he returned from military service in World War I. From 1920 to 1922 he was industrial power engineer for the Syracuse (N. Y.) Lighting Company. In 1922 he joined the United Gas Improvement Company as industrial power engineer, later engaging in electric rate studies and general supervision of all sales activities.

J. E. Yarmack (A ’35, M ’43) formerly commercial engineer and aviation application engineer, Federal Telephone and Radio Corporation, New York, N. Y., has been appointed technical representative, International Standard Electric Corporation, New York, N. Y., to foreign commissions in Washington, D. C. Born in Russia in 1900, Mr. Yarmack came to the United States in 1921, was graduated from the Massachusetts Institute of Technology in 1925, studied and taught at Yale University, New Haven, Conn., in 1926, and was naturalized in 1928. Previously he has been associated with the Consolidated Edison Company of New York, Inc., the American Telephone and Telegraph Company, the Square D Company, and the Diehl Manufacturing Company, all of New York. Since 1938 he has been associated with various subsidiaries of the International Telephone and Telegraph Corporation.

S. M. Cooper (A ’17) vice-president, United Gas Improvement Company, Philadelphia, Pa., has been elected president of the Delaware Power and Light Company, Wilmington. Mr. Cooper commenced his career in the utility field in 1914 as construction engineer, statistician, and distribution engineer, for the New York and Queens Electric Light and Power Company, Long Island City. Subsequently he was associated with the Counties Gas and Electric Company, Norristown, Pa., before joining the United Gas company as assistant to the electrical engineer. He has been vice-president of the Charleston (S. C.) Consolidated Railway and Lighting Company, the Philadelphia Suburban Counties Gas and Electric Company, and the Philadelphia Electric Company and president of the South Carolina Power Company, Charleston.

Harold Cole (A ’19, M ’27) formerly distribution engineer, Detroit (Mich.) Edison Company, has been appointed chief planning engineer. Graduating from Cornell University with the degree of mechanical engineer in 1916, he entered the employ of the Detroit Edison Company as assistant distribution engineer, becoming distribution engineer in 1923. **H. W. Collins** (A ’22, M ’42) formerly assistant to the superintendent of electrical systems has been appointed chief assistant superintendent of electrical systems. Mr. Collins, a graduate of the University of Michigan, had held his former position with the Edison Company since 1919. **G. C. A. Opp** (A ’27) formerly safety engineer, recently was appointed safety consultant for the company.

F. E. Brooks (A ’38, M ’42) formerly assistant vice-president, New York Telephone Company, New York, has been appointed chief engineer of the Long Island area of the company. Mr. Brooks, a graduate of the Case School of Applied Science, has been associated with the New York Telephone Company since 1912, excepting the duration of his service with the Signal Corps of the United States Army during World War I. Commencing his career in the engineering department, Mr. Brooks was made plant extension engineer for the Bronx–Westchester area in 1927 and for the Manhattan area in 1935. He became chief engineer for the Manhattan area in 1939 and assistant vice-president in 1942.

C. A. Cora (A ’02, M ’34) directory manager, Indiana Bell Telephone Company, Indianapolis, has retired. Born in Buffalo, N. Y., in 1898, Mr. Cora has been connected with the Bell Telephone system since 1899 when he was employed as assistant wire chief for the American Telephone and Telegraph Company in Buffalo. In 1904 he joined the Central Union Telephone Company, Indianapolis, as division wire chief, becoming division service inspector in 1907, general sublicense agent in 1908, and special agent in 1912. From 1915 to 1920 he was division commercial engineer. In 1920 he was appointed general commercial engineer for the Indiana Bell company and in 1937 was named directory engineer.

C. E. Plummer (A '33, M '37) formerly chief electrical engineer, Modesto (Calif.) Irrigation District, has been appointed chief engineer of the district. Born in Victoria, B. C., in 1901, Mr. Plummer commenced his career as radioman and electrician with the United States Coast Guard from 1921 to 1923. He was employed by the Turlock (Calif.) Irrigation District as electrician in 1923, becoming electrical and service foreman later that year and superintendent of distribution in 1929. In 1936 he joined the Modesto District as chief electrical engineer.

L. P. Joubert (M '35, F '41) formerly chief of the power-plant section of the engineering division of the district office of the United States Engineer, Denison, Tex., has been appointed head of the engineering division of the office. Mr. Joubert has been with the United States Engineers since 1934 when he worked on the Bonneville Project as associate engineer. More recently he has been senior engineer at the Bonneville (Oreg.) district office (1939–41), and at the Portland (Oreg.) district office during 1941.

W. A. Lewis (A '27, M '39) formerly director of the school of electrical engineering, Cornell University, Ithaca, N. Y., has resigned from that position to return to the field of engineering research. He has been named consulting electrical engineer to the Armour Research Foundation at the Illinois Institute of Technology, Chicago, and also research professor in the electrical-engineering department. (For a fuller biography of Doctor Lewis see *Electrical Engineering*, October 1943, page 461.)

L. R. Ludwig (A '28, M '41) division manager, switchgear department Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., has been named manager of the motor division of that company. Mr. Ludwig has been with the Westinghouse company since 1925 when he graduated from the University of Illinois. As the recipient of the first Lamme Memorial Scholarship, he studied at the University of Berlin in 1929 and 1930.

H. W. Stiner (A '15, F '43) consulting engineer, Cleveland, Ohio, now is associated with the firm of Peter F. Loftus, Consulting Engineers, Pittsburgh, Pa. Mr. Stiner was connected with the General Electric Company in Schenectady, N. Y., and later in Cleveland, from 1913, when he was graduated from Pennsylvania State College, until 1932. As a consultant since 1932 he has been engaged particularly in the central station and mining industries.

L. F. Adams (A '09, F '42) manager of the standards division, General Electric Company, Schenectady, N. Y., has been appointed head of the company's newly created standards policy committee. **H. W. Robb** (M '36) of the standards department and **P. L. Alger** (A '17, F '30) staff assistant to the vice-president in charge of engineering, also have been named to the committee.

Harvey McPhail (A '19, F '42) formerly assistant chief electrical engineer, United States Bureau of Reclamation, Denver, Colo., has been appointed head of the Bureau's new power utilization branch. A 1914 graduate of the University of Nevada, Mr. McPhail has been in the service of the Bureau since 1919 and has been assistant chief electrical engineer at Denver since 1931.

D. E. Howes (A '23, M '35) professor of electrical engineering, Norwich University, Northfield, Vt., has been granted a leave of absence to accept a position in the radio research laboratory, Harvard University, Cambridge, Mass. A graduate of Worcester Polytechnic Institute, Professor Howes joined the Norwich faculty as assistant professor in 1923.

T. C. McFarland (A '22, M '32) formerly associate professor of electrical engineering, University of California, Berkeley, has been appointed chairman of the electrical engineering department. He has been a member of the university faculty since 1920, when he was made instructor. In 1925 he became assistant professor and, in 1931 associate professor.

E. R. Thomas (A '25, M '30) on leave of absence from the Consolidated Edison Company of New York (N. Y.), Inc., has been promoted from the rank of major to that of lieutenant colonel in the United States Army. He is acting chief of research and development of communication equipment at Army Air Force headquarters, Washington, D. C.

E. H. Snyder (A '27, M '33) formerly assistant to the chief engineer, Public Service Electric and Gas Company, Newark, N. J., has been appointed assistant chief engineer. Mr. Snyder, who graduated from Lehigh University, joined the Public Service Company in 1923 as cadet engineer. He had been assistant to the chief engineer since 1937.

A. R. Wellwood (M '22, F '36) lieutenant colonel, Corps of Engineers, United States Army, recently was awarded the Legion of Merit by the War Department for exceptionally meritorious conduct in the performance of outstanding service as assistant to the commandant, Carolina maneuver area, First Army maneuvers, 1941.

J. A. Darling (A '21) formerly chief system dispatcher, Boston (Mass.) Edison Company, has been appointed assistant superintendent of the company's production department. Mr. Darling has been associated with the Boston Edison Company and its predecessor the Edison Electric Illuminating Company of Boston, since 1902.

C. E. Skinner (A '99, F '12) retired assistant director of engineering, Westinghouse Electric and Manufacturing Company, Ea Pittsburgh, Pa., is serving as civilian enginee in the executive office of the director of th Fort Monmouth (N. J.) Signal Corps Laboratory. Mr. Skinner was president of th AIEE for 1931–32.

R. E. Forman (A '40) formerly chief desig engineer, Pacific Power and Light Compan Portland, Oreg., has been appointed superintendent of construction and maintenanc A graduate of Washington State College, h joined the Pacific Power company in 191 and has been chief design engineer sinc 1935.

C. W. Jones (A '30) formerly deputy chie of the materials control branch of the Offic of War Utilities' power division, has bee named chief of the power division's equipment production branch. Before enterin Government service, Mr. Jones was associated with the New England Power Servic Company, Boston, Mass.

R. P. Brown (A '10, M '13) chairman of th board, Brown Instrument Company, Philadelphia, Pa., has been appointed deput director of the War Production Board, Thir Region. Since 1942 Mr. Brown has bee serving as regional consultant to the Defens Plant Corporation, subsidiary to the Reconstruction Finance Corporation.

C. H. Sanderson (A '07, F '18) retired system planning engineer, Consolidated Ediso Company of New York (N. Y.), Inc., ha joined the division of war research o Columbia University with headquarters i Pasadena, Calif. A fuller biography of M Sanderson appears in *Electrical Engineering* June 1943, page 271.

Zay Jeffries (M '36, F '42) technica director, lamp department, General Electrical Company, Cleveland, Ohio, has bee awarded the Gold Medal of the America Society for Metals, "in recognition of hi outstanding metallurgical knowledge an his great versatility in the application o science to the metal industry."

T. O. Eaton (A '28) assistant manager o power-transformer sales, General Electri Company, Pittsfield, Mass., has been mad manager of power transformer sales. M Eaton, formerly switchgear specialist a Philadelphia, Pa., was transferred to Pittsfield early in 1943.

R. E. Poole (A '24, M '34) broadcastin development engineer, Bell Telephone Laboratories, Inc., New York, N. Y., has receive the additional appointment of assistan director of commercial products development. He has been a staff member of th laboratories since their inception in 1925.

P. E. Bowen (A '41) formerly assistant engineer, Bell Telephone Company of Pennsylvania, Philadelphia, has been transferred t the equipment and building section, plan engineering division, operation and engineering department, American Telephon and Telegraph Company, New York, N. Y.

J. C. Damon (A '05, M '13) recently retire colonel, United States Army, has joined th staff of the Hartford (Conn.) Electric Ligh Company where he will engage in researc on depreciation. A fuller biography o

onel Damon appears in *Electrical Engi-*
ng, October 1943, page 462.

. Pearson (M '20, F '37) assistant to the
ident, Northwestern Electric Company,
land, Oreg., has been appointed co-
nator for Oregon and Washington in the
gram for co-operation between military
orities and electric companies in the
ern states.

ph Clark (A '26, M '35) engineer, on
e from the Consolidated Edison Com-
y of New York, Inc., now represents
hbach and Moore, Inc., electrical engi-
s and contractors, Fontana, Calif., in the
land, Calif., office of the iron and steel
sion of the Kaiser Company, Inc.

C. Streamer (A '10, M '41) vice-presi-
t, Westinghouse Electric and Manufac-
ng Company, East Pittsburgh, Pa., has
n named assistant to the president. Asso-
ed with the Westinghouse company since
7, Mr. Streamer was appointed a vice-
ident in 1941.

aden Pratt (A '15, F '37) vice-president
chief engineer, Mackay Radio and Tele-
h Company, and vice-president of the
eral Telephone and Radio Corporation,
in New York, N. Y., has been awarded
medal of honor of the Institute of Radio
ineers.

S. Gifford (A '16) president of the
erican Telephone and Telegraph Com-
y, New York, N. Y., recently was awarded
Vermilye Medal of the Franklin In-
te, "in recognition of outstanding con-
ution in the field of industrial manage-
t."

L. Lituchy (A '40) formerly design proj-
engineer, ignition engineering depart-
t, Allison Engineering Division, General
tors Corporation, Indianapolis, Ind., is
mechanical development engineer,
lins Radio Company, Cedar Rapids,
a.

. Rader (M '40) formerly electrical engi-
r, South Carolina Electric and Gas Com-
y, Columbia, has been appointed general
erintendent in charge of operation. He
been associated with the South Carolina
pany since 1925.

. Colson (A '25) engineer in the outside-
t-construction department, Consolidated
son Company of New York (N. Y.), Inc.,
been granted a wartime leave of absence
oin the Division of War Research, Wash-
on, D. C.

G. Walker (A '24, M '43) senior engineer,
ing section, engineering department, Phila-
hia Electric Company, has been ap-
ted a member of the sectional com-
tee on electrical measuring instruments
he American Standards Association.

R. Woodman (A '27) engineer in the
rating department, Southern California
son Company Ltd., Los Angeles, has been
de acting superintendent of hydro-genera-
. Mr. Woodman has been employed by
Edison Company since 1923.

C. Crossman (A '30, M '42) and **Howard**
ghtie (A '30) formerly assistant engi-
s in the electrical-engineering depart-
t of the Consolidated Edison Company of New York (N. Y.), Inc., are now captains in the United States Army.

E. H. Martindale (A '11, M '13) president and general manager, Martindale Electric Company, Cleveland, Ohio, has been appointed to the consolidated metal-cutting tool industries advisory committee formed by the War Production Board.

F. E. Hanson (M '39) manufacturing engineer, Western Electric Company, Kearny, N. J., has been appointed to the mica-capacitor-conservation industry advisory committee formed by the War Production Board.

S. C. Tallman (A '39) formerly a member of the technical staff, Bell Telephone Laboratories, Inc., New York, N. Y., now in England with the United States Army, has been promoted to captain in the mechanized cavalry.

A. B. Rosenstein (A '41) formerly senior electrical engineer, plant engineering department, Lockheed Aircraft Corporation, Burbank, Calif., is now with the Signal Engineering Products Corporation, Los Angeles, Calif.

W. G. Chandler (A '26) formerly superintendent of transmission, Brooklyn Edison Company, has been transferred to the Consolidated Edison Company of New York (N. Y.) Inc., as assistant superintendent of transmission.

J. H. Herron (M '35, F '41) president of the James H. Herron Company, Cleveland, Ohio, recently received the honorary degree of doctor of engineering from the Case School of Applied Science.

G. A. Kositzky (M '22, F '29) chief engineer, Ohio Bell Telephone Company, Cleveland, recently was honored with the degree of doctor of engineering by the Case School of Applied Science.

C. S. Kleinau (A '34, M '41) major, Signal Corps of the United States Army, has been designated acting chief of the aircraft radio branch of the engineering and technical service of the Office of the Chief Signal Officer.

T. F. Barton (A '12, F '30) commercial vice-president and district manager, General Electric Company, New York, N. Y., has accepted the chairmanship of the electrical division for the Fourth War Loan.

W. R. G. Baker (A '19, M '41) vice-president, General Electric Company, Bridgeport, Conn., has been appointed chairman of the new Radio Technical Planning Board of the Radio Manufacturers Association.

L. W. Bates (A '04, M '38) head of the power plant division, Bureau of Yards and Docks, United States Navy Department, Washington, D. C., has been promoted from the rank of commander to that of captain.

H. L. Logan (A '19, F '43) managing engineer, controlens division, Holophane Company, Inc., New York, N. Y., has been elected chairman of the New York section of the Illuminating Engineering Society.

C. J. Lake (A '39) formerly regulator engineer, induction-voltage-regulator department, General Electric Company, Pittsfield, Mass., has been transferred to the company's electronics division at Schenectady, N Y.

A. G. L. McNaughton (A '11, HM '42) lieutenant general, commander in chief, Canadian Active Service Force, recently was made an honorary member of the American Society of Mechanical Engineers.

E. G. D. Paterson (A '21) formerly outside-plant quality engineer, Bell Telephone Laboratories, Inc., New York, N. Y., has been appointed systems quality engineer at the laboratories.

R. W. Gilbert (A '36) formerly chief of the aircraft engineering division, Weston Electrical Instrument Corporation, Newark, N. J., has been made director of the company's Rockaway Valley laboratories.

R. C. Rifenburg (A '18, M '35) formerly division engineer, Consolidated Edison Company of New York (N. Y.), Inc., has become plant engineer for the American Locomotive Company, Schenectady, N. Y.

F. B. Wipperman (A '20) representative for the Railway Industrial Engineering Company, St. Louis, Mo., has been elected executive secretary of the National Industrial Service Association.

F. I. Lawson (A '34, M '38) who has been with the Federal Power Commission, Washington, D. C., since 1925, has entered the employ of the Braden Copper Company, Rancagua, Chile.

R. E. Doherty (A '16, F '39) president of the Carnegie Institute of Technology, Pittsburgh, Pa., has been elected president of the Society for the Promotion of Engineering Education for 1943–44.

G. W. Knauer (A '29) chief engineer and plant manager for the North Dakota area of the Northwestern Bell Telephone Company, Fargo, has been granted a wartime leave of absence.

J. A. Hale (M '26) vice-president of the Utah Power and Light Company, Salt Lake City, has been elected president of the Northwestern Electric Light and Power Association.

P. J. Stone (A '38) formerly assistant engineer, technical-service department, Consolidated Edison Company of New York (N. Y.), Inc., is a second lieutenant in the United States Marine Corps.

E. W. Seeger (A '16, F '36) manager of the development department, Cutler-Hammer, Inc., Milwaukee, Wis., has been elected president of the Engineers' Society of Milwaukee.

C. W. Pickells, Jr. (A '30) formerly assistant engineer, Consolidated Edison Company of New York (N. Y), Inc., is serving as a lieutenant in the United States Army in the South Pacific.

R. C. Earle (A '27) formerly assistant engineer, Brooklyn (N. Y.) Edison Company has been transferred to the gas-production department of the company's Astoria (N. Y.) plant.

E. C. Byrd (A '34) formerly tester, Consolidated Edison Company of New York (N. Y.), Inc., is now a corporal in the United States Army and is stationed at Hammer Field, Calif.

D. T. Osgood (A '37) formerly member of the technical staff, Bell Telephone Laboratories, Inc., New York, N. Y., has been promoted to major in the United States Army.

A. C. Marshall (A '14, F '29) president and general manager, Detroit (Mich.) Edison Company, has been elected president of the Detroit Industrial Safety Council.

H. L. Miller (A '38) president, Utilities Engineering Company, Philadelphia, Pa., has been elected president of the Electrical Association of Philadelphia for 1944.

G. T. Minasian (A '25, M '30) distribution engineer, Consolidated Edison Company of New York (N. Y.), Inc., has been elected mayor of Glen Ridge, N. J.

C. A. Collier (M '23) vice-president, Georgia Power Company, Atlanta, has been named president of the company's postwar planning committee.

L. F. Motl (A '30) formerly of the 50th Transport Wing, United States Army, Camp Williams, Wis., has been promoted to major and assigned to Pope Field, Fort Bragg, N. C.

Rawson Bennett II (A '38) formerly lieutenant commander, Bureau of Ships, United States Navy, Washington, D. C., has been promoted to the rank of commander.

OBITUARY • • • •

Axel Julius Körner (A '16, F '39) consulting engineer, Stockholm, Sweden, died in August 1943. Born April 12, 1880, in Stockholm, he was graduated from the Royal Institute of Technology in 1902. He entered the testing department of the Swedish General Electric Company, Vasteras, Sweden, in 1903 and became chief of the department in 1904. In 1906 he was connected with the General Electric Company, Schenectady, N. Y., and the Allis-Chalmers–Bullock Manufacturing Company, Montreal, Que. Returning to the General Electric Company in Sweden in 1907 he engaged in experimental work on railway motors and equipment. From 1911 to 1914 he directed the company's work on the first large single-phase electrification in Sweden and in 1915 was made chief engineer of the railway department. After a period, 1916 to 1919, as a consulting engineer, he was appointed chief engineer for the Luth and Rosén Electric Company and remained in that position from 1920 to 1923. Since 1924 he had practiced as a consulting engineer on electric power and railway electrification. Mr. Körner was also editor of the electrical section of the *Teknisk Tidsskrift* since 1918 and instructor in electrotechnics at the Royal Institute of Stockholm since 1931. He served as chief consulting engineer for the city of Stockholm on urban and suburban traffic problems and as member of the Swedish National Committee of the International Electrotechnical Commission and as president of the subcommittee on electric traction. He was president of the Swedish Institute of Electrical Engineers for 1921–22; vice-president of the Swedish Society of Consulting Engineers in 1932; and member of the board of Elektrotechnischer Verein, Berlin, Germay, 1933–35. He served his Government as member and secretary of the committees on railway electrification and on inductive interference from 1920–23; as secretary of the committee on electric-power taxes in 1930; and as special member of the royal court of taxation in 1936. He was the author of technical books and papers and holder of several patents.

Howard Burton Shaw (A '97) professor and head of the industrial engineering department, North Carolina State College, Raleigh, died December 15, 1943. Professor Shaw, who was born in Winslow, Me., August 5, 1869, received from the University of North Carolina the degrees of bachelor of arts in 1890, and bachelor of commercial science in 1891; and from Harvard University the degree of master of arts in 1894. He was instructor in mathematics at the University of North Carolina from 1889 to 1890 and instructor in surveying and drawing from 1891 to 1893. He was assistant in the electrical-engineering laboratory at the Lawrence Scientific School of Harvard University from 1894 to 1896. He joined the faculty of the University of Missouri in 1896 as assistant professor of electrical engineering and was named professor in 1899. He was appointed dean of the school of engineering in 1907 and director of the engineering experiment station in 1909. He served as commissioner on the Missouri Public Service Commission from 1913 to 1917 and afterwards as educational director of the Doherty Training Schools until 1922. He was first associated with the North Carolina State College as director of the engineering experiment station in 1923, and became professor of industrial engineering in 1932 and head of the department in 1941. He was a member of Phi Beta Kappa, Sigma Xi, Eta Kappa Nu, the Society for the Promotion of Engineering Education, and the Society for the Advancement of Management.

Murray Charles Beebe (A '98, F '13) in charge of the research department, Lea Manufacturing Company, Waterbury, Conn., died November 28, 1943. Mr. Beebe who was born February 25, 1876 and received the degree of bachelor of science in electrical engineering from the University of Wisconsin in 1897. He remained at the University of Wisconsin, Madison, as instructor in electrical engineering until 1900. After an interval as research engineer for George Westinghouse and the Nernst Lamp Company, Pittsburgh, Pa., he returned to the University of Wisconsin as head of the department of electrical engineering in 1907 and retained that position until 1918. During World War I he worked on submarine detectors and signaling devices at the Western Electric Company, New York, N. Y. He joined the Wadsworth Watch Case Company, Dayton, Ky., in 1920 as chief engineer, and the Scovill Manufacturing Company, Waterbury, in 1925 as director of its research laboratories. In 1942 he took charge of the research department of the Lea Company. Mr. Beebe served on the AIEE board of examiners for 1942–43. He was a member of the American Chemical Society and honorary member of the staff of the University of Connecticut. Several patents have been issued in his name. He was a member of Tau Beta Pi, Eta Kappa Nu, and Sigma Xi.

Brian Chandler Bellows (M '36) toll facili
ties director, Bell Telephone Laboratories
Inc., New York, N. Y., died December 22
1943. Born June 10, 1884, in Mandan, N
Dak., Mr. Bellows received the degree o
mechanical engineer from Cornell Universit
in 1906. Entering the employ of the Ameri
can Telephone and Telegraph Company
New York, N. Y., he studied service an
force requirements for the long-lines traffi
department and in 1909 was made toll lin
engineer. In that capacity he was employe
by the Western Union Telegraph Company
New York, N. Y., in 1912 and became traffi
engineer in 1914. Returning to the Ameri
can Telephone company in 1914 as servic
engineer, he was appointed division traffi
superintendent in 1920. In 1923 he wa
transferred to the Illinois Bell Telephon
Company, Chicago, as general supervisor o
toll traffic only to return to the America
Telephone Company in 1926 as toll switch
ing facilities engineer. His connection wit
Bell Laboratories dated from 1934 where h
became first toll facilities engineer and sinc
1935 director of toll facilities.

Harold Elijah White (A '03) design engi
neer, Wilkinsburg, Pa., died November 29
1943. Mr. White was born December 11
1875, in Camillus, N. Y., and was graduate
from Cornell University with the degree o
mechanical engineer in 1898. He com
menced his career as design engineer in th
railway engineering department for th
General Electric Company, Schenectady
N. Y., in 1899. In 1913 he entered th
employ of the Crocker-Wheeler Company
Ampere, N. J., as controller engineer, re
maining in that position until 1922 when h
took a position in the control engineerin
department of the Westinghouse Electri
and Manufacturing Company, East Pitts
burgh, Pa. His work for the Westinghous
company mostly pertained to marine auxi
iary controllers. Since 1932, he had bee
unemployed except for a short term of em
ployment with the Works Progress Adminis
tration. More than 25 patents had bee
issued in his name. He was a member o
the American Institute of Mechanica
Engineers.

W. Ward McKinley (A '38, M '42) chi
engineer, plant 5, the Sparks-Withingto
Company, Jackson, Mich., died Novembe
10, 1943. Mr. McKinley, who was born i
Harrisburg, Ohio July 24, 1908, was gradu
ated from Ohio University in 1927 with th
degree of electrical engineer. He was em
ployed by the Rochester and Pittsburgh Co
and Iron Company, Indiana, Pa., as co
analyst and steam-plant engineer from 192
to 1929, in which year he joined the Young
town (Ohio) Sheet and Tube Company
electrical draftsman and designer. Fro
1931 to 1937 he was electrical engineer f
the public water-supply system for Mahonin
Valley sanitary district, Youngstown. Wi
the Commonwealth and Southern Corpor
tion from 1937 to 1942, he supervised ele
trical design, particularly on automat
switching and remote indicating and mete
ing apparatus. In 1942 he entered t
employ of the Sparks-Withington Compa
as production engineer and chief draftsma

les E. Eckels (A '30) electronic engi-
Minneapolis-Honeywell Regulator
pany, Cleburne, Tex., died November
943, in a plane accident. He was born
ary 11, 1908, in Ben Avon, Pa., and
graduated from Carnegie Institute of
nology in 1928 with the degree of
elor of science. He was employed as
ant in the laboratory of inductive co-
ation school, American Telephone and
graph Company, New York, N. Y., in
and in 1929 was made instructor in
ompany's school for new technical em-
es in Pittsburgh, Pa., where he was
oyed until 1933. In 1935 he became
ct representative for A. M. Byers Com-
, Pittsburgh, Pa., and in 1940 was trans-
l to Lakewood, Ohio, as company
sentative. In 1943 he entered the
oy of the Minneapolis-Honeywell com-
, Minneapolis, Minn., and later was
ferred to Texas.

ge Guy Warwick (A '27, M '35)
intendent, Ruskin (B. C.) power plant,
ern Power Company of Canada, died
tly. He was born November 15, 1880,
urrey, England. He commenced his
r as an apprentice marine engineer for
ll and Thompson, Tonbridge, Kent,
and, in 1896. He also was connected
the Eadie Manufacturing Company,
ingham, England, and the Birmingham
l Army, Ltd., before leaving England
13 to enter the employ of the Vancouver
r Company at Lake Buntzen, B. C.
1915 to 1918 he served in the British
and from 1918 to 1920 worked for the
sh Columbia Electric Railway Com-
, Vancouver. Returning to the Van-
er Power Company in 1920 he worked
aster mechanic until 1926 when he was
superintendent at Lake Buntzen. In
he was appointed superintendent of the
in Power Plant.

ph E. Hood (A '38) department of water
power, City of Los Angeles, Calif.,
recently. Mr. Hood was born July 29,
, in Butte, Mont., and after holding
us apprentice mechanical and elec-
l positions in California and Arizona
me master mechanic for the Goodrich
hart Development Company, Jerome,
His association with the Los Angeles
rtment of water and power dated from
when he took charge of field mainte-
e and repair of electrical and hydraulic
er-plant and station machinery. In
he was given the official title of elec-
l foreman. Since 1935 he also had been
onsible for the electrical repair section,
general plant division, and, after 1936,
frequency change section. Supervision
he maintenance, repair, and necessary
sign of the electrical machinery at the
four 82,500-kva units at Boulder power
t was also among his duties.

n Percy Bender (A '18) assistant
ication manager, transformer division,
tinghouse Electric and Manufacturing
pany, Sharon, Pa., died October 22,
. Born in Pittsburgh, Pa., July 18,
, he was graduated from the University
ittsburgh in 1906 with the degree of
rical engineer. Joining the Westinghouse company in 1906 as an engineering apprentice, he was made transformer design engineer in 1907, and commercial engineer in 1911. In 1918 he served as a member of the War Industries Board, Washington, D. C. Appointed manager of the sales section for power transformers in 1919, he became transformer sales manager in 1935. In 1942 he was named assistant application manager. Mr. Bender was chairman of the AIEE Sharon Section for 1932–33 and a member of the National Electrical Manufacturers Association.

Daniel Frederic Potter, Jr. (M '31) manager of the New York, N. Y., office of the Kuhlman Electric Company, died November 5, 1943. Born September 15, 1893, in Buffalo, N. Y., Mr. Potter received the degree of mechanical engineer from Cornell University in 1916. After several months in the test course of the General Electric Company at Lynn and Pittsfield, Mass., he joined the Robertson-Cataract Electric Company, Buffalo, as sales engineer. In 1923 he became a partner in the firm of Hoffman and Potter which represented the Sundh Electric Company, Newark, N. J.; the Howell (Mich.) Electric Motor Company; the Peerless Electric Company, Warren, Ohio; and the Kuhlman Electric Company, Bay City, Mich. When this partnership was dissolved in 1924, he organized the New York office of the Kuhlman company.

John Vincent Hilford (A '35) assistant inspector, Philadelphia (Pa.) Signal Corps Procurement District, died September 18, 1943. Mr. Hilford was born December 16, 1910, in Caney, Kans., and was graduated from the University of Kansas with the degree of bachelor of science in electrical engineering in 1934. He was employed by the Kansas State Highway Commission in 1935 and entered the employ of the Phoenix Engineering Corporation, Wichita, Kans., in 1937. After periods of employment with the Kansas Gas and Electric Company, Wichita, and the Sedgwick County Engineers' Office, Wichita, in 1940, he entered the employ of the Government as civil engineer in Kansas City, Mo., in 1941 and was transferred to the Signal Corps of the United States Army later that year.

Maurice Herman Paleschuck (A '43) tutor in electrical engineering, College of the City of New York, N. Y., died December 28, 1943. He was born May 13, 1916, in New York City and was graduated from the College of the City of New York in 1942 with the degree of bachelor of electrical engineering. From 1935 to 1940 he was employed as an instructor to testers and trouble shooters by Emerson Radio and Television, Inc., New York, N. Y. In 1941 he became a laboratory assistant for the department of electrical engineering at the College of the City of New York and in 1942 was appointed tutor in electrical engineering. He was an associate member of the Institute of Radio Engineers.

Frank J. Reynolds (A '20) retired engineer, Hartford (Conn.) Electric Light Company, died December 19, 1943, in Rockymount, N. C. Born May 24, 1867, in Clermont, N. H., he was graduated from Dartmouth College in 1889. From 1889 to 1917 he was employed by the Thomson-Houston Electric Company and its successor, the General Electric Company. In 1890 he was made assistant district engineer for the company at Cincinnati, Ohio, and in 1898 general construction foreman in Schenectady, N. Y. In 1907 he was transferred to the New York (N. Y.) district where he had charge of the installation of large apparatus. In 1917 he joined the Hartford Electric Light Company as chief engineer.

MEMBERSHIP ● ●

Recommended for Transfer

The board of examiners at its meeting on January 20, 1944, recommended the following members for transfer to the grade of membership indicated. Any objection to these transfers should be filed at once with the national secretary.

To Grade of Fellow

Dewars, A. G., mgr., system planning, Northern States Power Co., Minneapolis, Minn.
Hoover, P. L., prof. of elec. engg., head of dept., Case School of Applied Science, Cleveland, Ohio.
Penman, R. F., chief sponsor engineer, Ebasco Services, Inc., New York, N. Y.
Sisson, C. E., managing engr., Canadian General Electric Co., Toronto, Ont., Canada.

4 to grade of Fellow

To Grade of Member

Allen, H. J., vice-president, Garrett Engg. Co., Houston Tex.
Beatty, Fred, associate professor of elec. engg., Colorado State College, Fort Collins, Colo.
Berger, F. J., senior engr., Philadelphia Electric Co., Philadelphia, Pa.
Billau, L. S., elec. engr., Baltimore & Ohio Railroad, Baltimore, Md.
Black, F. S., assistant system planning engr., Potomac Electric Power Co., Washington, D. C.
Bowman, J. C., engr., Public Service Elec. & Gas Co., Newark, N. J.
Churchill, T. C. D., foreign wire relations engr., Bell Telephone Co., Toronto, Ont., Canada.
Coffman, E. S., principal rate investigator, Federal Power Commission, Washington, D. C.
Eames, W. F., consulting engr., Westinghouse Electric Elevator Co., Jersey City, N. J.
Fellows, H. S., transformer dept. Supt. State Electricity Comm. of Victoria, Melbourne, Australia.
Gillespie, J. P., supt., Elec. pwr. and maintenance, Holston Ordnance Works, Tennessee Eastman Corp., Kingsport, Tenn.
Henderson, J. W., elec. engr., Washington Suburban Sanitary Comm., Hyattsville, Md.
Henschke, W. O., asst. research engr., American Bosch Corp., Springfield, Mass.
Lincks, G. F., head of design section, General Elec. Co., Pittsfield, Mass.
Logan, F. G., mgr. of development, Ward Leonard Elec. Co., Mt. Vernon, N. Y.
Lovoff, Adolph, elec. engr., Navy Dept., Bureau of Ships, Washington, D. C.
MacDonald, Wm. R., Major, Office of the Chief Signal Officer, Washington, D. C.
McAvoy, F. E., associate research and div. engr., and director of Target Div., General Bronze Corp., Long Island City, N. Y.
McCammon, F. F., vice-president in charge of elec. operations, Public Service Co. of Colorado, Denver, Colo.
Neubauer, E. O., transmission engr., Illinois Bell Telephone Co., Chicago, Ill.
Peck, H. B., post engr., Woodrow Wilson General Hospital, Staunton, Va.
Ramsay, H. B., senior electric distribution engr., New Orleans Public Service, Inc., New Orleans, La.
Reardon, J. W., designer, D.C. motors and generators, General Electric Co., Fort Wayne, Ind.
Rushmore, L. A., asst. supervising distribution engr., Long Island Lighting Co., Roslyn, N. Y.
Saldana, A. E., president and mgr., Cia. de Alumbrado Electrico de San Salvador, El Salvador, Central America.
Smith, P. D., elec. engr., Consolidated Steel Corp., Ltd., Orange, Tex.
Snively, H. D., motor and generator engg. div., General Electric Co., Schenectady, N. Y.
Taugher, F. P., New England District Engg. & Service Mgr., Westinghouse Elec. & Mfg. Co., Boston, Mass.
Wall, J. V., elec. engr., Vern E. Alden, Chicago, Ill.
Warner, C. W., engr., Cutler-Hammer, Inc., Milwaukee, Wis.

30 to grade of Member

Applications for Election

Applications have been received at headquarters from the following candidates for election to membership in the Institute. Names of applicants in the United States and Canada are arranged by geographical District. Any member objecting to the election of any of these candidates should so inform the national secretary before February 29, 1944, or April 30, 1944, if the applicant resides outside of the United States or Canada.

To Grade of Member

Adler, W. M. (Re-election), Fischbach & Moore, Inc., Alexandria, Va.
Bailey, F. W., Capt., U. S. Army, Columbus, Ohio.
Berumen, J. A. (Re-election), Calle de Blanco, Torreon, Coah., Mex.
Bobe, S. A., Westinghouse Elec. and Mfg. Co., Atlanta, Ga.
Bogdanowicz, W. A. (Re-election), Clinton Engineer Works, Oak Ridge, Tenn.
Brodhead, W., Weston Electrical Instrument Corp., Boston, Mass.
Burris, A. P., Electric Machinery Mfg. Co., Minneapolis, Minn.
Colby, C., Utilities Section, S.C.A.D., A.P.O. 726, c/o Postmaster, Seattle, Wash.
Croll, H. A., Ill. Bell Tel. Co., Chicago, Ill.
Ingalls, R. D. (Re-election), Diehl Mfg. Co., Somerville, N. J.
Holmdahl, N. G., U. S. Bureau of Reclamation, Coulee Dam, Wash.
Howk, C. L. (Re-election), Federal Tel. & Radio Corp., East Newark, N. J.
Karplus, E., General Radio Co., Cambridge, Mass.
Larsh, E. P., The Master Electric Co., Dayton, Ohio.
Leidigh, W. A., Jr. (Re-election), Portland Gen. Elec. Co., Portland, Oreg.
Little, D. G., Westinghouse Elec. & Mfg. Co., Baltimore, Md.
Maxon, R. D. (Re-election), Public Service Co. of Ill., Chicago, Ill.
McIlvaine, D. K., Alco Valve Co., St. Louis, Mo.
Olschner, E. W., Carolina Tel. & Tel. Co., Tarboro, N. C.
Peterman, L. C. (Re-election), Ford, Bacon & Davis, Inc., New York, N. Y.
St. Clair, H. (Re-election), Tennessee Valley Authority, Chattanooga, Tenn.
Short, C. W., United States Rubber Co., Bristol, R. I.
Thompson, P. W., Detroit Edison Co., Detroit, Mich.
Tietze, H. W. (Re-election), Public Service Elec. & Gas Co., Newark, N. J.
Weaver, B. S. (Re-election), General Electric Co., Schenectady, N. Y.
Wentzel, A. G., Jr., Aluminum Co. of America, Burlington, N. J.
Whiting, F. T., Westinghouse Elec. & Mfg. Co., Chicago, Ill.

27 to grade of Member

To Grade of Associate

United States and Canada

1. NORTH EASTERN

Aubuchon, M. A., General Elec. Co., Schenectady, N. Y.
Bowser, R. V., Allis-Chalmers Mfg. Co., Boston, Mass.
Brueckner, L. J., Bell Aircraft Corp., Buffalo, N. Y.
Burton, Lester W., General Electric Co., Bridgeport, Conn.
Cameron, D. H., Major, U. S. Army, Bradley Beach, N. J.
Ericson, C. H., General Elec. Co., Buffalo, N. Y.
Fellers, R. G., Yale Univ., New Haven, Conn.
Gibson, H., General Elec. Co., Schenectady, N. Y.
Haeussler, F. B., General Elec. Co., Boston, Mass.
Hoffman, H. P., Bristol Co., Waterbury, Conn.
Hsu, E. T., General Elec. Co., Schenectady, N. Y.
Larock, F. N., So. New England Tel. Co., New Haven, Conn.
Macredis, G., Westinghouse Elec. Elevator Co., Jersey City, N. J.
McKinney, C. R., General Elec. Co., Schenectady, N. Y.
Pinkham, T. A., Jr., Boston Edison Co., Boston, Mass.
Shafer, O. B., Int. Bus. Mach. Corp., Endicott, N. Y.
Shumata, J. W., General Elec. Co., Lynn, Mass.
Straight, A. L., Blackstone Valley Gas & Elec. Co., Pawtucket, R. I.
Thomas, H. W., New York State Electric & Gas Corp., Binghamton, N. Y.
VanKirk, S. D., New York State Elec. & Gas Co., Elmira, N. Y.
Wagner, J. L., International Bus. Mach. Corp., Endicott, N. Y.
Williams, J. R., General Elec. Co., Schenectady, N. Y.

2. MIDDLE EASTERN

Abele, W. B., The Ohio Power Co., Philo, Ohio.
Acock, G. W. (Re-election), J. A. Roebling's Sons, Trenton, N. J.
Bancroft, W. H., Jr., Ed. G. Budd Mfg. Co., Philadelphia, Pa.
Barden, W. A., Major, U. S. Army, Dayton, Ohio.
Benedict, P. T., U. S. Army Signal Corps, Audubon, N. J.
Berghoefer, F. G., Naval Research Lab., Washington, D. C.
Brannen, P. M., Union Switch & Signal Company, Swissvale, Pa.
Conway, C. B., Consolidated Gas Elec. Light & Pr. Co., Baltimore, Md.
Danielson, G. K., Sr., Goodyear Aircraft Corp., Akron, Ohio.
Davis, R. E., Naval Research Lab., Washington, D. C.
Dennis, C. R., Chesapeake & Potomac Tel. Co., Washington, D. C.
Driver, J. P., Radio Corp. of America, Lancaster, Pa.
Emans, J. B., Bureau of Ships, Washington, D. C.
Faike, J. A. (Re-election), General Elec. Co., Cincinnati, Ohio.
Flath, E. H., Jr., Univ. of Cincinnati, Cincinnati, Ohio.
Flynn, J. V. (Re-election), Master Electric Co., Dayton, Ohio.
Halsted, R. L., Allis-Chalmers Mfg. Co., Charleston, W. Va.
Jenkins, R. W. (Re-election), Cons. Gas Elec. Light & Pr. Co. of Baltimore, Baltimore, Md.
Joline, E. R., Philadelphia Electric Co., Philadelphia, Pa.
Kirkpatrick, E. L., U. S. Navy, Washington, D. C.
Langell, S. A., Zanesville, Ohio.
Locke, J. F., U. S. War Dept., Dayton, Ohio.
Mitchell, C. A., Day & Zimmermann, Inc., Philadelphia, Pa.
Moss, B. W., Western Elec. Co., Inc., Baltimore, Md.
Osborne, C. H., Electric Storage Battery Co., Pittsburgh, Pa.
Payne, H., Wright Field, Dayton, Ohio.
Reed, A. L., West Virginia Univ., Morgantown, W. Va.
Schantz, G. W., Master Electric Co., Dayton, Ohio.
Schweinfurth, D. F., Tel. & Tel. Services, Portsmouth, Ohio.
Shields, A. B., Victoreen Instrument Co., Cleveland, Ohio.
Smith, S. L., Philadelphia Trans. Co., Philadelphia, Pa.
Stafford, K. E., Cleveland Elec. Ill. Co., Cleveland, Ohio.
Wallin, C. I., Westinghouse Elec. & Mfg. Co., Cleveland, Ohio.
Wehmann, G. W., Sylvania Elec. Prod., Inc., Emporium, Pa.
Young, E. L. (Re-election), General Motors Corp., Dayton, Ohio.

3. NEW YORK CITY

Beirne, W. J., Airborne Instrument Labs., Mineola, N. Y.
Bomer, P. A., Federal Tel. & Radio Corp., East Newark, N. J.
Burns, L. L., Jr., Lieut., U. S. Army, New York, N. Y.
Cohen, C. L., Federal Radio & Tel. Corp., East Newark, N. J.
Fritschy, V. P., Westinghouse Elec. Elev. Co., Jersey City, N. J.
Gurevics, D., Freed Transformer Co., New York, N. Y.
Heath, E. H., Jr., Westinghouse Elec. Elev. Co., Jersey City, N. J.
Hickson, R., Long Island Lighting Co., Roslyn, N. Y.
Huse, E. L., Jr., Jersey Central Pr. and Lt. Co., Asbury Park, N. J.
Kolmorgen, E. L., Anaconda Wire & Cable Co., Hastings on Hudson, N. Y.
Marsteller, D. M., New York Tel. Co., Brooklyn, N. Y.
Perry, W. P., Curtiss-Wright Corp., Caldwell, N. J.
Pollacek, E. H., Federal Tel. & Radio Corp., East Newark, N. J.
Rhein, G. W., Mackay Radio & Tel. Co., New York, N. Y.
Rich, E. M., 222 E. 35th St., New York, N. Y.
Unfricht, A. J., W. S. Rockwell Co., New York, N. Y.
Walker, E. C., Curtiss-Wright Corp., Caldwell, N. J.
Welk, S. E., War Research Div., Columbia Univ., Mineola, N. Y.
White, K. E., Electrical Testing Labs., New York, N. Y.

4. SOUTHERN

Allison, R. W., Robert & Co. Inc., Atlanta, Ga.
Brower, W. E., Memphis Light, Gas & Water Div., Memphis, Tenn.
Burton, W. A., West Virginia Pulp & Paper Co., Covington, Va.
Elder, G. R., Sr. (Re-election), Dept. of Public Utilities, Radford, Va.
Morgan, P. N., Tenn. Valley Auth., Chattanooga, Tenn.
Roach, J. L., Alum. Co. of America, Alcoa, Tenn.
Shirley, R. C., Tenn., Eastman Corp., Oak Ridge, Tenn.
Shoemaker, F. B., Tenn. Valley Auth., Chattanooga, Tenn.
Stewart, F. G., Jr., Alum. Co. of America, Alcoa, Tenn.
Wiggins, C. Q., Jr., Alum. Co. of America, Alcoa, Tenn.
Wright, I. R., Alum. Co. of America, Alcoa, Tenn.

5. GREAT LAKES

Cronau, G. G., Cutler-Hammer, Inc., Milwaukee, Wis.
Dodge, W. A., Jr., U. S. Army, Fargo, N. Dak.
Durand, S. R., Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Fairly, A. S., Commonwealth & Southern Corp., Jackson, Mich.
Jerome, B. A., Bemis Bros. Bag Co., Peoria, Ill.
Krug, J. P., Detroit Edison Co., Detroit, Mich.
Markese, M. S., Delta Star Electric Co., Chicago, Ill.
Miller, N. E., Allis-Chalmers Mfg. Co., West Allis, Wis.
Montgomery, W. O., Pub. Serv. Co. of Ind., Indianapolis, Ind.
Morris, J. P., Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Ragsdale, W. H., General Motors Corp., Flint, Mich.
Robinson, R. R., Board of Public Works, Niles, Mich.
Schroeder, J. M., Univ. of Minn., Minneapolis, Minn.
Storaasli, B. A., Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Stroh, W. J., Zenith Radio Corp., Chicago, Ill.
Swayne, J. B., Illinois Pr. Co., Bloomington, Ill.
Wilkins, H. F., Lafayette, Ill.
Williams, S. B., Globe-Union, Inc., Milwaukee, Wis.
Williams, V., Westinghouse Elec. and Mfg. Co., South Bend, Ind.
Wimmer, E. V., Kyle Corp., South Milwaukee, Wis.
Wright, T. D., Square D Co., Detroit, Mich.

6. NORTH CENTRAL

Gaunt, O. M., American Tel. & Tel. Co., Denver, Co
Morgan, H. A., Westinghouse Elec. & Mfg. C Denver, Colo.
Ramsey, J. D., Remington Arms, Inc., Denver, Colo.
Williams, W. T., Bur. of Reclamation, Kremmlin Colo.

7. SOUTH WEST

Blackman, H. W., Pennsylvania Shipyards, Beaumo Texas.
Boone, H. C., Univ. of Okla., Norman, Okla.
Byrd, E. C., Winston Bros. Co., Port Neches, Texas.
Chamberlain, P. S., Westinghouse Elec. & Mfg. C El Paso, Texas.
Council, J. B., Westinghouse Elec. & Mfg. Co., Housto Texas.
Dear, J. F., Pennsylvania Shipyards, Inc., Beaumo Texas.
Erhart, F. J., Southwestern Bell Tel. Co., St. Lou Mo.
Gust, M. J., J. Gordon Turnbull & Sverdrup & Parc St. Louis, Mo.
Harder, D. C., Oklahoma Gas & Elec. Co., Oklaho City, Okla.
Hussers, J. A., Southwestern Bell Tel. Co., St. Lou Mo.
Kendall, F. P., American Smelt. & Ref. Co., Vanadiu N. M.
Mangum, G. R., Southwestern Bell Tel. Co., St. Lou Mo.
Metzdorf, E. K., AT&SF Ry. Co., Topeka, Kans.
Parmele, E. G., Electric Service Supplies, Inc., Dall Texas.
Peery, C. A., Texas Co., Dallas, Texas.
Rall, F. A., Southwestern Bell Tel. Co., St. Louis, M
Rather, D. I., Houston Pipe Line Co., Houston, Tex
Rey, W. A., Oklahoma Gas & Elec. Co., Oklahoma Ci Okla.
Shaw, R. W., Aluminum Co. of America, Malve Ark.
van der Meulen, J. F. W., Tin Processing Corp., Te City, Texas.
Zavada, A. J., Square D Co., Houston, Texas.

8. PACIFIC

Adamson, R. T., Westinghouse Elec. & Mfg. Co., L Angeles, Calif.
Dwyer, F. J., Board of Education, San Francisco, Cal
Hegardt, K. E., Southern Calif. Tel. Co., Los Angel Calif.
Lipscomb, W. L., Cons. Vultee Aircraft Corp., S Diego, Calif.
Male, A. N. (Re-election), Southern Calif. Tel. C Los Angeles, Calif.
McKee, R. W., Southern Calif. Tel. Co., Los Angel Calif.
Miller, W. A., Southern Calif. Tel. Co., Los Angel Calif.
Minvielle, L., U. S. Navy, San Francisco, Calif.
Peairs, M. H., Douglas Aircraft Co. Inc., Santa Moni Calif.
Shackman, D. E., Southern Calif. Tel. Co., Los Angel Calif.
Sproul, J. E., Southern Calif. Tel. Co., Los Angel Calif.
Wallace, S. J., Western Pipe & Steel Co., South S Francisco, Calif.

9. NORTH WEST

Carlson, E. L., Puget Sound Power & Light Co., Seatt Wash.
Hamilton, R. F., Northwestern Elec. Co., Portland, Ore
Hughes, H. R., E. I. duPont de Nemours & Co., Pasc Wash.
Johnson, C. L., Winslow Marine Rwy. & Shipyar Winslow, Wash.
Kinyon, A. L., Bonneville Power Admin., Portlan Oreg.
Scarborough, W. E., Bonneville Power Admin., Po land, Oreg.
Schrengohst, J. H., Puget Sound Power & Light C Dieringer, Wash.
Worth, R. A., Northwestern Electric Co., Portlan Oreg.

10. CANADA

Buckley, E. F., Univ. of Toronto, Toronto, Ont., Can.
Gareau, E. A., McGill Univ., Montreal, Que., Can.
Mason, C. T., Redfern Construction Co. Ltd., We Toronto, Ont., Can.
Millican, G. W., Montreal Light Heat & Power Co Montreal, Que., Can.
Thomson, A. G., Canadian Gen. Elec. Co., Lt Peterboro, Ont., Can.

Elsewhere

Arguelles, C. R., Elec. Engr., Mexico, D. F., Mex.
de Jesus, P. M., Rio de Janeiro Tram., Lt. & Pr. C Ltd., Rio de Janeiro, Brazil, S. A.
Desdier, F., CIA Industrial de Guadalajara Atemaj Jal., Mex.
Fernandez, A., Neuva Cia. Electrica Chapala, S. Guadalajara Jal., Mex.
Fernandez Varela, C., Westinghouse Elec. Int. C Monterrey, N. L., Mex.
Garduno Fernandez, J., Comunicacions y Obras Pu licas (SCOP), Mexico, D. F., Mex.
Jasso, C. G., Nua Cos. El. Chapal, S. A., Quadalaja Jal., Mex.
Meaney, A., Gen. Elec. Co., Guadalajara, Jal., Mex.
Pena, P. G., Elec. Engr., Herramientas, Mexico, D. Mex.
Quirarte, L., CIA Ind. Nel. S. A., Guadalajara, J Mex.
Tavera, E. G., Institute Cordiologio, Mexico, D. Mex.

Total to grade of Associate
United States and Canada 158
Elsewhere 11

OF CURRENT INTEREST

ew Committee to Study Power
Needs of Liberated Areas

A Public Utilities Committee has been
ganized to "assemble all pertinent facts
d recommend such action as may be ad-
sable concerning requirements, supplies,
d production of equipment to re-establish
ctric, gas, and water services in liberated
d former enemy areas which may be re-
ired during the relief period," according to
cent announcement by the Combined
oduction and Resources Board.

The United Nations Relief and Rehabilita-
n Administration will refer requirements of
erated areas to the Combined Board for
nsideration in relation to other military
civilian claims for the same supplies. The
mbined Board will make recommendations
how far the requirements put forward
UNRRA can be met and from what
urce; the Public Utilities Committee will
sist the Combined Board to perform this
sk in its particular field.

The chairman of the committee and
merican member will be J. A. Krug, di-
ctor of the Office of War Utilities, War
oduction Board. The member for Great
itain will be Sir Henry Self, deputy United
ingdom member of CPRB; the member for
nada will be T. H. Hogg, chairman of the
ydro-Electric Power Commission of On-
rio.

The Committee is expected to survey re-
uirements and the availability of utility
uipment and to decide, in conjunction
th other operating organizations of the
ree governments, on any necessary produc-
n programs for equipment to meet basic
ility needs in liberated and former enemy
eas.

NDUSTRY• • • • •

,000-Kw Power Plant Installed
in Eight Railroad Cars

A 5,000-kw central station has been de-
gned which may be completely assembled
a railway train of eight cars. It is adapted
r using coal of unusually low quality and
erating in arid regions and in temperature
nges from 110 degrees above to 40 degrees
low zero Fahrenheit. The power plant, a
oduct of Westinghouse Electric and Manu-
cturing Company, can be set up to de-
ver power in 48 hours' time, it is reported.

The first two cars carry the air-cooled
ndensers, while third car carries the turbine
nerator with switchgear equipment. The
urth and fifth cars take care of auxiliary
uipment and water storage. The water
orage supply will run the train, under most
vere conditions, for more than a full day
ithout replenishment. The sixth and
venth cars are for the boilers while the
ghth provides quarters for the crew and
orage for lubricating oils, spare parts, and
forth.

The two boilers produce steam at 600 pounds gauge, 750 degrees Fahrenheit from available coals—even lignite, having a heat content of only 7,000 Btu per pound, will work satisfactorily. Boilers are of water-tube double-drum construction and have both forced and induced draft fans and air-operated locomotive-type stokers. The single turbine-generator unit delivers to the bus 6,250 kva at 80 per cent power factor, 6,300 volts. Power is delivered to a six-cubicle, metal-clad switchgear for distribution. Because intake ventilating air may be dusty or dirty, the generator is provided with a self-cleaning air filter. A Diesel-driven generator provides 75 kw capacity for plant and auxiliary purposes.

Four motor-driven propeller fans draw air over eight coolers in each of the condenser cars. Even with cooling air at 95 degrees Fahrenheit the condensers are able to condense the full amount of steam; the condenser water is then pumped back to the feed-water tank car. By this method it is expected that less than three per cent make-up water will be required. All make-up water is filtered, softened, and evaporated in the auxiliary car.

Placing a modern 5,000-kw plant into a train of eight cars presented scores of engineering problems. The trucks were designed to be specially rigid so that no torsional movement of the frame in transit can rupture pipe connections. All apparatus—meters, shafts, gauges, and so forth—are braced so as not to be injured by a sudden stop of the train. Pipe and electric circuits between cars are disconnected while the train is en route. Because of the tight fit in the turbine-generator car, the sides are removable to give access to the generating unit should dismantling be necessary. Therefore, supports for a crane, overhead piping, and conduit are all built up independently from the floor.

TVA Releases Annual Report

A net income of $13,148,000 was returned to the United States Treasury from gross revenues of $31,670,000 accruing from the sale of electric power by the Tennessee Valley Authority during the fiscal year ending June 30, 1943, according to the report submitted by that body to the President on January 1, 1944. TVA also reported the receipt of gross revenues of $34,670,000 and a combined net income of $5,806,000 by the 128 municipal and co-operative distribution systems which are wholesale customers of TVA, serving 523,000 ultimate consumers.

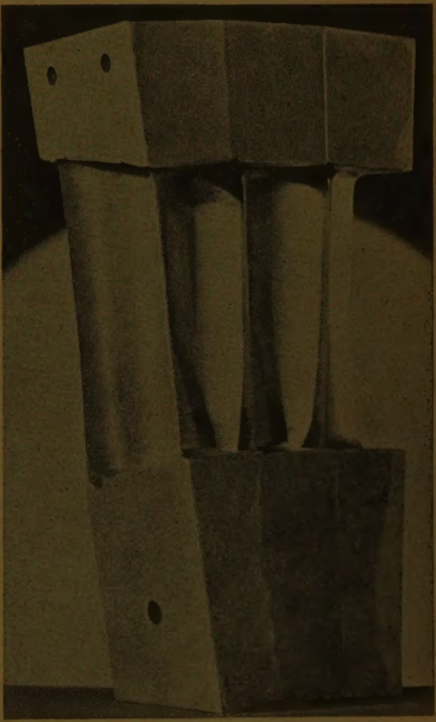
Most of the other varied activities TVA reported for the year were connected with the war effort. Of the 9,000,000,000 kilowatt-hours of electric energy generated, three quarters were used by war industries. Production of 77,300 tons of concentrated phosphatic fertilizers for food production in Great Britain and the United States and development of equipment and techniques for preserving food were reported. Large quantities of ammonia, ammonium nitrate, and elemental phosphorus for munitions and calcium carbide for synthetic rubber were produced; 24,000 square miles of strategic areas were mapped for the War Department; electric generating plants were designed for the Soviet Government; Army medical officers were trained in methods of malaria control; training in resource-development administration was provided for engineers from South American countries and from China; and new mobile housing construction methods for use in war projects were developed.

Copies of the report may be obtained from the Superintendent of Documents, Washington, D. C.

New Turbine Blade Evolved

A new impulse turbine blade suitable for use on large 3,600-rpm units which it is said will pass a life test of 1,000 hours with no indication of weakening has been evolved as a result of a four-year research program. The turbine blade, now in use at Westinghouse Electric and Manufacturing Company, is smaller than the old one—1½ inches wide instead of 2. The root by which it is fastened to the turbine rotor is shaped like an inverted U. Three of these blades are brazed together, forming one solid segment. Each three-blade segment is fastened to the rotor by two crosswise pins.

During the four-year program several types of blades were tested on a special test turbine, with a wide variety of temperatures, loads, and speeds. About 120,000 photographic records were taken of the turbine in operation.



Segment of new impulse turbine unit

Lighting Handbook Issued by Westinghouse Lamp Division

A Lighting Handbook, designed as a practical guide and working reference book for lighting engineers, designers, architects, and builders and originally scheduled for release after the war, has been issued by the lamp division of Westinghouse Electric and Manufacturing Company.

A feature of the handbook is a series of charts which co-ordinate room index, fixture efficiency, and coefficient of utilization curves and provide a new and graphic method of determining the desired illumination for various applications. Charts cover industrial and commercial fluorescent and incandescent lighting and provide a means of calculating quickly the number and size of lamps needed with practically every type of lighting fixture.

The book is divided into two parts, chapter headings in the first section including: Lighting Terms and Measurements, Recommended Levels of Illumination, Interior Lighting Design Calculations, Interior Wiring for Lighting. In the second half of the book, devoted to specific lighting applications, there are chapters covering store, office, school, public buildings, industrial, architectural, aviation, and street and highway lighting.

A limited number of copies is available at one dollar each.

147,000-Kw Turbogenerator Installed in Chicago Station

A new 147,000-kw turbogenerator, reputed to be the largest steam generating unit to be built in the United States since the beginning of the war, has been placed in service at the Fisk station of the Commonwealth Edison Company in Chicago. This generator which feeds energy into the power pool embracing the territories served by Commonwealth Edison Company, Public Service Company of Northern Illinois, Western United Gas and Electric Company, and Illinois Northern Utilities Company, brings the aggregate system net capacity to 2,254,000 kw. A peak system load of 1,928,000 kw was registered on December 15, 1943.

Operating at a speed of 1,800 rpm and at a steam pressure of 1,300 pounds per square inch, the new unit is driven by two pulverized-coal-fired boilers with a combined capacity of 100 tons of coal per hour and capable of delivering 1,500,000 pounds of steam per hour. The Allis-Chalmers Manufacturing Company constructed the turbogenerator and Babcock and Wilcox Company the boilers.

Tiny Fluorescent Lamp Designed. A new fluorescent lamp consuming one tenth of a watt, suitable for marker purposes where low illumination with low energy consumption is desirable, has been announced by Westinghouse Electric and Manufacturing Company. The lamp contains two spiral electrodes in a gaseous atmosphere. A discharge takes place when about 100 volts alternating current or 140 volts direct current is applied across the electrodes. A tiny resistor in the lamp base stabilizes current flow after discharge begins.

American Edition of Engineers' Digest Issued

An American edition of *The Engineers' Digest*, an English technical journal reporting on progress in engineering research and development abroad, was introduced into the United States in December 1943. Created to enable a large number of readers to keep in touch with the significant engineering articles selected, digested, and translated from magazines published overseas, the new edition will continue to be published monthly in this country.

Copies of the digest, or an annual subscription, can be obtained by writing to E. D. Publications, Inc., 1 Madison Ave., New York 10, N. Y. Two of the 30 abbreviated articles appearing in the first issue are on electrical subjects.

The prototype of the American *Engineers' Digest* was established in England in 1940. It was designed to circumvent the language handicap, and to isolate for the attention of busy engineers with limited reading time the noteworthy articles from the world's engineering literature. It functions through a committee of what may be termed specialist engineers, formed for consultative purposes to sift the journals of other countries for desirable papers, and to supervise their condensation and translation.

OTHER SOCIETIES •

Fatalities in Electric Utilities Analyzed in NSC Report

Analysis of the circumstances and causes of fatal accidents in electric utilities, based on the details of 193 fatal and 29 other severe accidents reported by members of the public-utilities section of the National Safety Council, has been made in the Council's Accident Facts Memo *U-1* "Deaths and Serious Injuries Resulting From Electric Shock and Burns in the Electric Utility Industry."

Electric shock and burns resulted in by far the highest proportion of the fatalities—70 per cent, or 136 cases. Fatal falls from poles, ladders, trees, and towers ranked next, accounting for 13 per cent, or 24, of the deaths. Accidents caused by motor vehicles were third.

The unsafe acts of employees were factors in 95 per cent of the accidents. Lack of safeguards, particularly the use of rubber gloves, line hose, and rubber blankets, was a factor in 50 per cent of the instances. Failure to use protective equipment was usually the result of disobedience of instructions by the injured person and was the outstanding personal cause.

The majority of fatal accidents occurred in handling wires and tools in removing or installing lines and transformers; splicing and connecting wires and other apparatus; and inspecting and repairing, re-fusing, and checking switches, transformers, and similar equipment. Another outstanding factor was work done on hot lines which could have been degenerized. Since electrocutions are responsible for such a large percentage of the fatal injuries, elimination of the principal causes of such accidents offers the biggest opportunity for reducing deaths in the industry.

Future Meetings of Other Societies

American Institute of Mining and Metallurgical Engineers. Annual meeting, February 20–24, 1944, New York, N. Y.

American Society for Testing Materials. Spring meeting, March 1–2, 1944, Cincinnati, Ohio; 47th annual meeting, June 26–30, 1944, New York, N. Y.

American Society of Mechanical Engineers. Spring meeting, April 3–5, 1944, Birmingham, Ala. Semiannual meeting, June 19–20, 1944, Pittsburgh, Pa.

Engineering Institute of Canada. Annual meeting, February 1–11, 1944, Quebec, Que.

National Electrical Manufacturers' Association. April 23–7, 1944, Chicago, Ill.

National Fire Protection Association. May 8–11, 1944, Philadelphia, Pa.

RMA Names Eight New Committees for War and Postwar Work

Eight new committees of Radio Manufacturers Association, for immediate work on many problems of the war program and for future plans and conferences with government agencies on postwar industrial problems, have been appointed by R. C. Cosgrove of the Crosley Corporation, Cincinnati, Ohio; chairman of the RMA set division and of the postwar planning committee.

The committees and their chairmen are:

Industry reconversion—A. S. Wells of Wells-Gardner and Company, Chicago, Ill.; former president of RMA.

Employment and personnel—A. H. Gardner of Colonial Radio Corporation, Buffalo, N. Y.

Sales financing—J. P. Rogers of Farnsworth Television and Radio Corporation, Fort Wayne, Ind.

Industry statistics—Ross D. Siragusa of the Admiral Corporation, Chicago, Ill.

Advertising—John S. Garceau of the Farnsworth Television and Radio Corporation, Fort Wayne, Ind.

Distribution costs—Ben Abrams of Emerson Radio and Phonograph Corporation, New York, N. Y.

Export program—W. A. Coogan of the RMA export committee.

Contract terminations—chairman not yet announced.

The committee on postwar planning will co-ordinate the work and consider detailed recommendations of the various groups.

International Illumination Conference Report Available

The essential substance of the proceedings of the last prewar International Illumination Conference held in Holland in June 1939 has been made available by the United States National Committee of the International Commission on Illumination in a condensed all-English version, with table of contents and index. Copies may be obtained at five dollars each (less than the cost of publication) from Arthur A. Brainerd, executive secretary of the Committee, Philadelphia (Pa.) Electric Company, 900 Samson St.

The proceedings of the ten-day Holland conference, which in former years have been reproduced in three languages, originally were to have been printed in Austria. However, German invasion at the outbreak of the r prevented this, as it later prevented the lland National Committee, which acted host during the meeting, from assuming ponsibility for publication. The United ites National Committee then undertook preservation of an unofficial report.

ectron Microscope Society Holds First Meeting

A comprehensive review of the effect of the ctron microscope on the development of entific research and production control was ovided by the program of the first official eeting of the Electron Microscope Society America, an associate society of the Ameri- n Institute of Physics, in New York, N. Y., nuary 14 and 15, 1944.

In particular the Stanford University and e General Electric microscopes were dis- ssed. Papers on lenses and specimen prepa- tion, on the microscope's application in e fields of biology and metals and alloys, d its use in determining molecular weights ere presented.

The officers of the new society are: R. B. rnes, American Cyanamid Company, amford, Conn., *president;* A. F. Prebus, hio State University, Columbus, *vice- esident;* M. C. Banca, Magnolia, N. J., *retary-treasurer;* and V. K. Zworykin 1 '22), Princeton, N. J., O. S. Duffendack, niversity of Michigan, Ann Arbor, *di- tors.*

CEA Specifications for Cable Revised. terim revisions of the Insulated Power able Engineers Association Specifications r Varnished Cambric Insulated Cables, urth Edition, July 1939, to be effective ring the war emergency period, have been nounced. These revisions which have also een adopted by National Electrical Manu- cturers Association cover Section 8.2, loth and Varnish Coating; Section 13.1, lass of Braid; Table IX, Thickness of raid; Section 14.1, Tape; Section 21.3, sulation Resistance Correction Factors; able XV; Tables XVI and XVII, Mini- um Insulation Resistance.

OINT ACTIVITIES

SA Approves War Standard for Glass Radio Insulators

The American Standards Association has nnounced the approval of a new American Var Standard for Glass Radio Insulators 75.8-1943), developed by a group of rep- esentatives of the radio industry in conjunc- on with representatives from the Signal orps and the Bureau of Ships. The project as undertaken at the request of the War roduction Board to aid in the preparation of ew manufacturing facilities for glass insu- tors, and it is expected to facilitate pro- uction of these units as well as to simplify eir procurement for the Armed Forces.

The specifications cover performance re- uirements, test methods, and standard di- ensions for a standard series of glass insu- tors of the quality required by the Army nd Navy. The detailed information is il- strated by a number of diagrams, and the appendix of the Standard is comprised of design criteria considered in good practice. The basic specification for glass material is the American War Standard on Ceramic Insulating Materials, class *L* (C75.1-1943).

Copies of the new Standard may be obtained at 50 cents per copy from the ASA, 29 West 39th St., New York 18, N. Y. Also it may be obtained without charge, for procurement purposes only, from the government agency concerned.

ASA Publishes New List of Standards

The American Standards Association announces the publication of its new list of standards, covering specifications for materials, methods of tests, dimensions, definitions of technical terms, procedures, and the like. More than 600 standards are listed, 64 of which have been approved or revised since publication of the last price list in April 1943. Among others, the new list includes 95 safety standards.

Since the war, the ASA has been working very closely with the Government agencies and with the Armed Forces to provide specifications for certain of the materials necessary to the war effort. Because these standards are developed through an accelerated procedure, they are designated as American War Standards and are listed separately. Already there are 40 of these completed and many more are under development. Every Government order is based on specifications, and these standards are used to accelerate production, conserve materials, maintain a balance between quality and price control, and to simplify inspection, contracting, and subcontracting.

The complete list of American Standards will be sent free of charge to anyone interested. Requests should be addressed to the American Standards Association, 29 West 39th St., New York 18, N. Y.

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

"Faith of the Engineer"

To the Editor:

During the Christmas respite I have been pondering "The Faith of the Engineer," as approved by Engineers' Council for Professional Development, and published in the December 1943 issue of *Electrical Engineering.* Though not a religious creed, it bears a close relationship to it, since true religion must express itself in the whole of life, of which one's profession or means of livelihood constitutes so large a part.

If the EPCD statement is examined from this point of view, the dominant note is the Christian ethic. The ideals of honesty, integrity, and service to humanity are exalted as the things which will give our profession dignity and in which we may take a humble pride. Rightly so.

Then there is a paragraph beginning, "Since the Age of Stone, human progress has been conditioned by the genius of my professional forebears." Is this the Christian conception of human progress? In these days surely we must recognize that human progress is more truly measured by spiritual qualities than by the multitude of material comforts and conveniences, and our greatest need is the spirit of brotherhood whereby the world may be made safe for scientific advances and their applications. The sentence quoted sounds rather materialistic and perhaps even arrogant.

While the distinctive contribution of engineers to society is of a material nature, engineers as a class are not blind to the fact that a basically spiritual problem is not solved by physical and material means. I believe that engineers are not behind others in recognition of the supreme value of the spiritual forces that make for righteousness and for peace on earth, good will among men. Should not "The Faith of the Engineer" remind us of the pre-eminence of these spiritual values?

C. KENT DUFF (M '41)

(Meter engineer, Hydro-Electric Power Commission of Ontario, Toronto)

NEW BOOKS • • •

The following new books are among those recently received from the publishers. Books designated ESL are available at the Engineering Societies Library; these and thousands of other technical books may be borrowed from the library by mail by AIEE members. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books. All inquiries relating to the purchase of any book reviewed in these columns should be addressed to the publisher of the book in question.

American Patent System. By W. B. Bennett. Louisiana State University Press, Baton Rouge, La., 1943. 259 pages, illustrated, 9 by $5^1/_2$ inches, cloth, $3. (ESL.)

Written from an economic viewpoint, this book describes our patent system and discusses its uses and abuses. Many questions involving the patentee, the corporate concern, and the public are answered explicitly, with reference to court decisions and the opinions of research workers and businessmen. The book is intended to be of use to students, inventors, corporations, and interested laymen.

Mac's (MacQuown's) Directory of Coal Operating Companies. Eighth edition. National Coal Publications, Berger Building, Fourth Avenue and Grant Street, Pittsburgh, Pa., 1943. 204 pages, 12 by 9 inches, stiff paper, $7.50. (ESL.)

This directory lists the coal operating companies of America by states and by names of companies and of mines. The names of officials and purchasing agents and information as to equipment, number of employees, daily output, and yearly output for the years 1938–41 inclusive are given.

Planning 1943. American Society of Planning Officials, 1313 East 60th Street, Chicago, Ill. 1943. 175 pages, charts, etc., $9^{1}/_{2}$ by 6 inches, cloth, $2. (ESL.)

The proceedings of the 1943 meeting of the American Society of Planning Officials and the papers presented at the meeting are included in this volume. Among the topics discussed are the effect of the war upon our cities, regional councils in metropolitan areas, national planning, urban redevelopment and the planning problems of cities.

Alternating-Current Circuits. By R. M. Kerchner and G. F. Corcoran. Second edition. John Wiley and Sons, Inc., New York, N. Y.; Chapman and Hall, London, England, 1943. 553 pages, illustrations, etc., $8^{1}/_{2}$ by $5^{1}/_{2}$ inches, cloth, $4.75. (ESL.)

This is a textbook intended for junior students who have had the usual courses in calculus. The new edition has been revised thoroughly and rearranged somewhat, and many illustrative examples and problems added.

Fundamentals of Radio. By L. O. Gorder, K. A. Hathaway, and C. H. Dunlap. American Technical Society, Chicago, Ill., 1943. 373 pages, illustrated, $8^{1}/_{2}$ by $5^{1}/_{2}$ inches, cloth, $2. (ESL.)

This textbook is intended for a first-level course following the War Department's recommended outline. It covers general electrical and radio theory, the principles and use of basic radio equipment, acoustics and acoustical apparatus, and the construction of transmitters and receivers. A glossary of terms is included.

Piping Stress Calculations Simplified. By S. W. Spielvogel. McGraw-Hill Book Company, New York, N. Y., and London, England, 1943. 83 pages, illustrated, $11^{1}/_{2}$ by $8^{1}/_{2}$ inches, cloth, $2.50. (ESL.)

This volume provides exact solutions to numerous typical problems in the calculation of pipe stress under changing temperatures. Arithmetical solutions are presented and the mathematical theory involved is discussed. The book is intended to assist the designer of piping layouts.

Patent Law. By C. H. Biesterfeld. John Wiley and Sons, New York, N. Y.; Chapman and Hall, London, England, 1943. 225 pages, $8^{1}/_{2}$ by $5^{1}/_{2}$ inches, cloth, $2.75.

The basic principles of our patent law are presented and illustrated by citation of and quotation from court decisions. The book is intended for persons without legal training who, in their daily work, are confronted at times with questions of patent law and practice.

Symposium on Paint. American Society for Testing Materials, Philadelphia, Pa., 1943. 60 pages, illustrated, 9 by 6 inches, paper, $1; to members, 75 cents. (ESL.)

This booklet contains seven papers presented at the Buffalo spring meeting of the ASTM in 1943. The papers deal with developments in drying oils and fatty acids; with surface coating of opaque pigments and calcium carbonate extenders; and with emulsion paints, paints for protective concealment, black-out paints, and luminous paints.

Radiographic Inspection of Metals. By O. Zmeskal. Harper and Brothers, New York, N. Y., and London, England, 1943. 150 pages, illustrated, $7^{3}/_{4}$ by 5 inches, cloth, $2.75. (ESL.)

This introductory manual gives a clear practical account of methods of radiographic inspection of metals. The equipment used, the fundamentals of radiographic practice, and the applications are discussed.

Mechanical Loading of Coal Underground. By I. A. Given. McGraw-Hill Book Company, New York, N. Y., and London, England, 1943. 397 pages, illustrated, $9^{1}/_{2}$ by 6 inches, cloth, $4. (ESL.)

Theory and practice are both covered in this manual. Many mining plans for all types of equipment and all seam conditions are given. The varieties of equipment are described. Face preparation power supply, and the maintenance of equipment also are discussed.

House of Goodyear. By H. Allen. Goodyear Aircraft Corporation, Akron, Ohio, 1943. 417 pages, illustrated, $9^{1}/_{2}$ by 6 inches, cloth, $2. (ESL.)

This history traces the development of The Goodyear Tire and Rubber Company from its organization in 1898 down to the present day. In addition to being the story of a great enterprise, it is an important contribution to the history of rubber, the development of modern business, and the relations of capital and labor.

Clear the Tracks! By J. Bromley. McGraw-Hill Book Company (Whittlesey House Division), 1943. 288 pages, woodcuts, $8^{1}/_{2}$ by $5^{1}/_{2}$ inches, cloth, $2.75. (ESL.)

This autobiographical work is a humorous and nostalgic story of the "good old days" when railroading was a personalized affair. Along with the personal narrative of the author's experiences runs a background of detail showing the growth of the railroads from the early wood-burning locomotive days to the present.

Aircraft Electrical Engineering. By R. Matson. McGraw-Hill Book Company, New York, N. Y., and London, England, 1943. 372 pages, illustrated, 9 by 6 inches, cloth, $3.50. (ESL.)

This text is intended for courses in aircraft electrical engineering which prepare the student as directly as possible for such work in the engineering departments of aircraft factories. An acquaintance with electrical theory is assumed, and the theory of design is omitted. Emphasis is on the practical problems that confront the engineer.

ASTM Methods of Chemical Analysis of Metals 1943. American Society for Testing Materials, Philadelphia, Pa., 323 pages, illustrated, $9^{1}/_{2}$ by 6 inches, cloth, $2.50; paper, $2. (ESL.)

This volume contains adopted and tentative standards for apparatus and reagents, for sampling, and for the analysis of commercial metals and alloys. The methods are intended for use in the buying and selling of materials according to specifications.

Steam Turbine Operation. By W. J. Kearton. Fourth edition. Pitman Publishing Corporation, New York, N. Y.; Sir Isaac Pitman and Sons, Ltd., London, England, 1943. 375 pages, illustrated 9, by $5^{1}/_{2}$ inches, cloth, $5. (ESL.)

The popularity of this practical text on the installation, running, maintenance, and testing of steam turbines, is shown by the publication of four editions in 12 years. In addition to instructions, the author has included descriptive matter which will enable the engineer to understand the construction of the plant and which explains the thermal and mechanical considerations that affect its operation. The chapters on glands and governing have been rewritten for this edition, and a chapter on thrust bearings has been added.

PAMPHLETS • • •

The following recently issued pamphlets may be of interest to readers of "Electrical Engineering." All inquiries should be addressed to the issuers.

Building Codes—An Essential Tool in Urban Development. Chamber of Commerce of the United States, Washington, D. C., 15 pages.

The Rubber Industry and the War. The Rubber Manufacturers Association, Inc., 444 Madison Avenue, New York, N. Y., 80 pages.

They're Turbosupercharged. General Electric Company, Publicity Divisions, Schenectady, N. Y., 32 pages, no charge.

Research in Steatite Porcelains. By J. O. Semmelman, J. W. Lennon, and A. S. Watts. The Ohio State University, Columbus, 47 pages, 50 cents.

Production for Victory, 1943. National Association of Manufacturers, 14 West 49th Street, New York 20, N. Y., 64 pages, 25 cents.

The Tocco Process. By H. B. Osborn, Jr., The Ohio Crankshaft Company, Cleveland 1, 32 pages.

What Management Can Really Do to Reduce Absenteeism. 28 pages. **Representative Cost Systems in the Plastics Industry.** 16 pages. **Preventing and Correcting Low Power Factor.** 8 pages. **Scientific Selection of Office Personnel Increases Production.** 4 pages. George S. May Business Foundation, 111 South Dearborn Street, Chicago 3, Ill., no charge.

Fires in the Second Year of War. National Fire Protection Association, 60 Batterymarch Street, Boston 10, Mass., 23 pages, 25 cents.